AN ECONOMIC EVALUATION OF THE INCOME, EMPLOYMENT AND DISTRIBUTIONAL ASPECTS OF A SUPERVISED CREDIT PROGRAM IN THE ZONA DA MATA, BRAZIL

BY

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Abstract of Dissertation Presented to the Graduate Council
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By

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The Brazilian agricultural sector has expanded rapidly in recent years. Nonetheless, there has been little economic development in many rural areas, even in the fast growing Southeast. The Zona da Mata region, despite its favorable location within the Minas Gerais State, is one of these economically depressed areas. Many factors have contributed to the backwardness of this region. The land itself is poor. During the coffee era the land was exploited by poor managers and traditional agricultural practices. Since then, development of the region has been stalled by limited infrastructure and erratic agricultural policy. Recently, financial resources from the World Bank, technical assistance and other institutional resources were brought together in the Integrated Rural Development Program of the Zona da Mata (PRODEMATA) with the objective of improving the socioeconomic conditions of the rural population.

The purpose of this study was to evaluate the impact of the PRODEMATA program on factor employment, income growth, and income distribution of those farmers who participated in the program. The data used were collected by the Department of Agricultural Economics of Federal University of Vicosa during the 1976/77 to 1981/82 time period. This study was limited to an evaluation of the 1978/79 and 1981/82 data.

The impact of PRODEMATA on factor employment was measured by comparing systems of demand equations for participants and non-participants in the PRODEMATA program. The demand equations were derived from Cobb-Douglas cost functions estimated from the survey data. Standard statistical tests, Lorenz curves and Gini coefficients were used to compare differences in income levels and distribution between participant and non-participant farmers.

The empirical findings of this study were unexpected, yet conclusive. By 1981/82 PRODEMATA had exerted no significant impact on the production structure of the farmers who participated in the program. That is, there was no measureable induced technological change during the study period. Consequently, no changes were observed in the estimated demand for labor or for other inputs. The estimated impact of the program on income growth was also negligible. Finally, no significant differential changes occurred in the estimated pattern of the income distribution among participant farmers in the sample.

CHAPTER I
INTRODUCTION

Extractive or primary industry dominated the colonial period of Brazilian economic history. The first settlers in Central Brazil came in search of gold and precious stones. Soon thereafter agriculture flourished. The Brazilian agricultural sector has produced timber, sugar, cotton, cocoa and coffee, primarily in response to foreign demand. The initial tenancy pattern of colonial agriculture has persisted to today in the farm sector, greatly influencing contemporary patterns of ownership and land use (CIDA, 1966). Prior to the 1950's Brazil's economy was based on primary production. By 1950, the share of agriculture in the Gross National Product (GNP) had declined to about 28 percent even though more than 60 percent of the economically active population was in the agricultural sector (Baer, 1979).

The shift to secondary industries began in the mid-1950s when import substitution policies were adopted. Following the serious political and economic crises culminating in 1964, comprehensive strategies for economic recovery led to a very stable period. Recently, Brazil has followed a more capitalistic and market oriented strategy than most developing countries (Fields, 1980).

After 1967 the rates of growth of GNP, as a result of a "boom" in the industrial sector, were three or more times the rate observed in the two years preceding 1964. Industry, especially some branch of high technology, was responsible for more than two-fifths of the growth in

GNP (Kadar, 1980). Growth started to decline in the mid-1970s as a result of higher costs of imported petroleum, and tight monetary and fiscal policies established to overcome difficulties in the balance of payments (Fields, 1980).

At the same time, diversification occurred in the agricultural export base. Sugar, soybeans, and some processed agricultural foodstuffs joined coffee and cacao as the major components of the country's exports (Graham, 1978). The country's average growth of real Gross Domestic Product (GDP) was about 5.9 percent in the period 1968 to 1976 and the real growth of GDP in the agricultural sector was 5.7 percent. In spite of this dynamic growth, many rural areas continued to be characterized by traditional, subsistence-oriented farming practices.

Despite the high rates of growth achieved, the change in the income distribution gave "much less cause for satisfaction" (Fishlow, 1972). General agreement exists that growth benefited only a few groups in the Brazilian society (Singer, 1975; Lopes, 1975). The share of the top 5 percent of the income recipients increased from 27.4 to 36.3 percent between 1960 and 1970. The share of the lowest 40 percent declined from 11.2 to 9.0 percent while the next 40 percent of the income recipients declined from a share of 34.4 to 27.8 percent (Baer, 1979).

Income growth and the changing pattern of distribution were not uniformily distributed throughout the Brazilian economy. Real income per urban worker increased more rapidly than real income per agricultural worker. The rates of growth of income concentration were more substantial in the industrialized areas such as Sao Paulo State compared to the more backward regions such as northeastern Brazil.

Income concentration grew more pronounced in urban areas while absolute poverty, measured by the percentage of the population below the minimum wage level, remained the usual characteristic of the rural areas (Graham, 1978).

Several factors may have contributed to the concentration of income in Brazil. The adoption of capital-intensive technologies after World War II, when the efforts for industrialization of the country took place, contributed to already existent inequalities in income distribution. In recent decades, income concentration has also been attributed to the policy of setting "ceilings" to limit wage increases. This policy was set as one of the strategies for economic recovery after stagnation of the country in the period 1962 to 1967 (Hoffman, 1975). Also, the widespread use of tax incentives to direct resources toward specific regions and sectors of the economy contributed to income concentration because most programs benefited only the higher income groups. Moreover, high rates of growth in the industrial sector increased the demand for scarce skilled labor and drove up their wages relative to those of unskilled labor (Baer, 1979). Finally, income concentration may have reduced employment growth since the industries which produce for higher income groups tend to be capital using (Baer, 1979). The source of income inequalities in the rural sector has been said to be the agrarian structure which is closely related to concentration in land distribution.

Lately, there has been increasing emphasis in Brazil on policies that favor low income groups. Improvements in the level of income and employment and a more egalitarian distribution in the rural sector have been set as objectives for Brazilian agriculture. Priority has been given to the agricultural sector in order to eliminate sectoral imbalances between agriculture and industry, increase agricultural exports, enlarge job opportunities, increase the supply of food, develop alternative sources of energy, and improve nutrition and health conditions, especially of the poor (Kadar, 1980).

This study is concerned with the impact of a rural development program on small farmers in the state of Minas Gerais. The program was designed on the assumption that subsidized loans for small farmers and sharecroppers, coupled with technical assistance, would induce them to improve the technology in use, thereby increasing farm productivity and income. The unique thing about this particular program is that it represents a departure from the past, when efforts to improve the economic status of small farmers were almost completely dismissed in Brazil. An assessment of the program achievements is attempted in this research by examining the economic changes which occurred in the study region during a three-year period of the program (1978/79 to 1981/82).

Problem Statement

Few studies exist concerning equity problems in the agricultural sector in Brazil. Little attention has been given in the economic literature to the role of small subsistence farmers, sharecroppers, and rural laborers in the economic growth process. Alternatives commonly offered to improve the situation of these groups include (a) resettlement of small farmers on new lands, (b) creation of agribusiness industries to absorb the surplus labor, (c) stimulation of migration to the more developed sectors, (d) introduction of new crop mixes (Teixeira Filho and Sugai, 1982), and (e) extension of subsidies to small farmers so that they can increase the rate of adoption of new technologies.

Awareness concerning the income disparities and regional imbalances caused by economic growth led the Brazilian government to provide ample research support to evaluate development programs designed to improve the incomes and welfare of disadvantaged groups. In order to stimulate growth in many of its less developed regions, the government has initiated several regional rural integrated development programs. The basic philosophy of the rural integrated programs is to integrate human capital, financial resources, and new forms of organization to induce self-sustained growth in those areas (Pita, 1982).

One recent effort within this framework is the Integrated Rural Development Program for the Zona da Mata in the state of Minas Gerais. The Portuguese acronym for this project is PRODEMATA. PRODEMATA is financed by the World Bank and managed by the State Development Agency (RURAL MINAS) in cooperation with several other state institutions under the overall coordination of the State Secretariat of Planning (SEPLAN). The production component of the program is designed to benefit approximately 140,000 people, of which almost 90 percent are classified as small farmers or sharecroppers working on land holdings of 100 hectares or less (World Bank, 1976).

PRODEMATA predicted a 10 to 20 percent rise in agricultural output as a result of adoption of improved techniques and alternative crop mixes in the region. Incomes were expected to increase about 60 percent over the present level and employment opportunities were projected to increase by 4.6 percent by the end of the project. An analysis of the contribution of this integrated rural development project in increasing farm productivity, incomes, and rural employment will provide guidance in the future formulation of economic policy in the region. The results will also be of importance for a broader scope of economic policy since more than 60 percent of food production in Brazil comes from small farms (Teixeira, 1981).

Research Objectives

This study seeks to analyze the PRODEMATA project and to evaluate its impact on agricultural employment, income growth, and changes in income distribution. Specifically, the following objectives are set:

(a) to analyze the impact of the PRODEMATA project on factor employment in the region;

(b) to analyze the impact of PRODEMATA project on farm income growth in the region; and

(c) to analyze the effects of the project on the distribution of income.

Plan of Dissertation

This study is organized in six chapters. The introductory chapter focuses on the research problem and the objectives of the study. Chapter II describes geographic and socioeconomic characteristics of the agricultural sector of the Zona da Mata. A description of the PRODEMATA policy and information concerning the collection and preparation of the data used in the research are also provided in this chapter. Chapter III presents the theoretical framework for this study. The neoclassical theory of factor employment and income distribution is reviewed. Two sections are dedicated to duality theory and cost functions. Personal distribution of income is the focus of the last section. Chapter IV is dedicated to the evaluation of the impact of PRODEMATA on factor employment. This chapter contains the empirical model and the procedures used for testing the hypotheses. A summary of the empirical findings closes the chapter. Chapter V evaluates the impact of PRODEMATA on the level and distribution of farm income. Standard statistical procedures, Lorenz curves, and Gini coefficients are used for comparisons between groups of farmers. The empirical findings are also presented in this chapter. Finally, in Chapter VI the research problem, conclusions and implications of the empirical findings are summarized. Limitations of the study and suggestions for further research are presented in the last section of the chapter.

CHAPTER II
THE STUDY REGION

Features of the Geographic Setting

This section highlights the main features of the Zona da Mata geographic setting, social infrastructure, and agricultural product mix. Information concerning the economic evolution of Zona da Mata and a description of the objectives and program components of the Integrated Rural Development Program of Zona da Mata (PRODEMATA) are also provided. The last section describes the collection and preparation of the data used in the research.

Physiographic Characteristics

The Zona da Mata region is located in the southeastern portion of Minas Gerais, bordered by the states of Rio de Janeiro, and Espirito Santo to the south and east (Figure 2-1). It is situated within the triangle formed by the state capitals of Belo Horizonte, Sao Paulo, and Rio de Janeiro. These three cities are among the most important urban centers of the Central South region of Brazil. The area of the Zona da Mata represents 6.1 percent of the total of Minas Gerais State.

The climate is generally mild and subtropical. Average rainfall is about 1,400 mm a year, with maximum precipitation occurring from October to March. Although rainfall is irregular in many areas, water is a relatively abundant resource in the region.

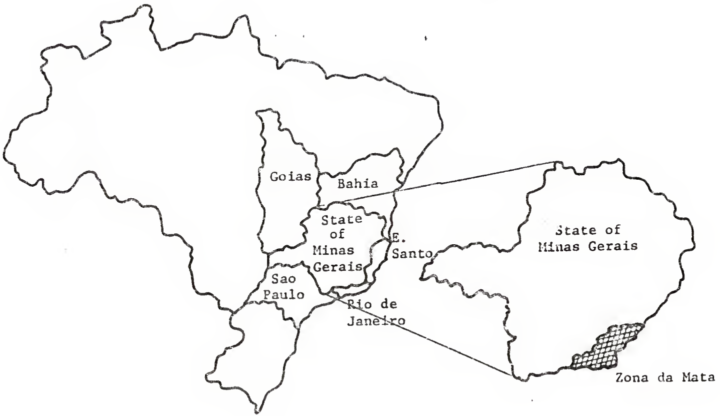

Figure 2-1. Brazil, State of Minas Gerais, and Zona da Mata

The topography of the Zona da Mata is characterized by a complex set of plateaus with elevations from 300-400 m up to 1,500 m. The surface is generally rolling to hilly, with half-dome shaped peaks which descend to plains and valleys. Lowlands are found only in a few areas in the vicinity of rivers. Only 16.3 percent of the land is classified as flat. Soils are relatively high in clay and moderately to highly weathered. The main soil types are the Red Yellow Latossols (Oxisols) and the Red Yellow Podzols (Ultisols) which are mostly found in the highlands and terraces, respectively (Resende, 1980). In the lowlands and valley bottoms some relatively fertile alluvial soils occur.

Social and Human Aspects

A population in excess of 1,600,000 inhabitants lives within the Zona da Mata, of which approximately 58.6 percent live in urban areas. The average annual rate of population growth in the 1950 to 1970 period was 1.6 percent. This is much lower than the Brazilian population growth rate of about 2.8 percent, so the emigration from the region in recent decades has been sizeable. Consequently, the rural population decreased from 70 percent of the total in 1950 to 41.4 percent in 1975.

Standard education and health services are meager in rural Zona da Mata. State and municipio (county) budgets are barely adequate to maintain existing services let alone to expand. Most of the privately owned services are too expensive for common rural inhabitants. Sixty percent of the rural laborers do not know how to read or to write. The attendance rate at elementary schools in Zona da Mata is approximately 60 percent of the 7- to 11-year-old population. An illiteracy of 55 percent is observed among the 5- to 14-year-old population. The dropout rate of the four year primary school program is well above 80 percent (World Bank, 1976; UFV, 1971).

The poor educational standards of the rural population are a consequence of several factors such as low perception of the social and economic value of education, participation of children in farming activities, and lack of schools and teachers in some areas. Moreover, the quality of teaching is deeply hurt by the lack of adequate teacher training programs and low teacher salaries. Low pay causes many teachers to quit in search of higher paying jobs.

The public and semi-public facilities for the provision of health services treat at most 10 percent of the rural population. Private business adds no more than 30 percent in attendance capacity. The average number of hospital beds is about 5 per 1,000 inhabitants, of which about 70 percent are in the private sector in large regional cities (World Bank, 1976; Silva, 1981).[1]

Only about 0.7 physicians per 1,000 inhabitants are in charge of health care services of the population in the project area. Most of the doctors in Zona da Mata are concentrated in a few metropolitan areas, leaving most rural areas with few or no medical services (World Bank, 1976).

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[1] Regional status of health infrastructure as a whole is comparable to the situation observed in Brazil. The number of hospital beds per 1,000 people, considering the country as a whole, was about 3.78 in 1975 and there were about 0.66 physicians per 1,000 inhabitants (Kurian, 1978). The worst of the situation is that the majority of the specialized people in health care are located in the already developed areas while the interior suffers all kinds of deficiencies. Brazilian numbers contrast sharply with the U.S. where on average there were 6.6 hospital beds and 1.5 physicians per 1,000 people in 1975 (United Nations, 1978).

The precarious economic conditions and deficient sanitary infrastructure result in the proliferation of several kinds of infections and endemic diseases including schitosomiasis. High mortality and morbidity rates are observed among the adult population due to communicable diseases. Malnutrition is frequently the single or an associated cause of infant and child mortality in the region (World Bank, 1976).

Resource Use and the Crop Mix

Land use and the structure of land plays an important role in the regional economy. Land use is to a large extent conditioned by topographic characteristics of the region. Vast areas are covered by natural pastures on hilly terrain constituted of poor, eroded soils which are inadequate for most agricultural enterprises. In these areas extensive livestock production predominates. The topography and the poor quality of soils limit the expansion of agricultural area and dictate the relatively low productivity in the region (UFV, 1971).

Considerable concentration in land ownership is observed in Zona da Mata, as in other regions of Brazil.[2] About 52 percent of the farms in the region have less than 20 hectares of land, yet those farms account for only 8.7 percent of the total agricultural land. On the other hand, 55 percent of the land is held by a small group of large farms. Only 4 percent of all farms are larger than 200 hectares, while 89 percent are smaller than 100 hectares.

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[2] The Gini coefficient for land distribution in the region, computed from agricultural census data of 1975 was 0.68, according to an estimate by Silva (1981).

Investment in farm machinery and equipment in the Zona da Mata is quite low and usually concentrated on the large farms dedicated to coffee and dairy enterprises. Most of the subsistence agriculture relies on labor, hoes, axes, and other rudimentary tools. Most of the hired labor available in the region is supplied by small farm owners and sharecroppers. Sharecroppers and farm owners of land holdings smaller than 10 hectares depend heavily on family labor for their operations.

The use of modern inputs is, in most cases, limited. For example, average expenditures in the 1976/77 PRODEMATA sample indicated that Zona da Mata farmers spent about 60 percent of the state average for purchases of fertilizers and pesticides (Silva, 1981).

The typical mix of agricultural enterprises within the region varies in accordance with climate, topography, population density, soil fertility, and geographic peculiarities. Among the perennial crops, coffee is the most important. It is mostly cultivated on larger farms. Producing areas for coffee, citrus, and banana are more heavily concentrated in the northern portion of the region.

In the southern region, dairy production is important to supply the Rio de Janeiro market. Dairy and beef livestock are prevalent on farms larger than 100 hectares in the Zona da Mata. As a result of the expansion of this enterprise in the region, about 70 percent of the rainfed land is currently used for pastures.

In the central portion of the region where small sized farm holdings predominate, a larger proportion of the total land base is dedicated to annual subsistence crops. The most important annual crops are corn, beans, rice, sugar cane, and tobacco.

Other activities of the region's farm sector are horticulture, forestry, poultry, and swine production. Horticulture is concentrated in the vicinity of the larger urban areas. Poultry and swine are found on farms throughout the region. These activities are economically important only for a small number of farms (UFV, 1971).

Evolution of the Regional Economy

Prior to World War II, coffee was the dominant agricultural activity in the Zona da Mata. The expansion of the coffee frontier from the Vale do Paraiba to Minas Gerais was the result of the favorable conditions of soils, good climate, and the very strategic position of the Zona da Mata in relation to major markets. However, the lack of adequate management and proper agricultural practices degraded the soils and produced increasingly lower yields.

Brazil conducted a coffee eradication program in 1962 to 1966. Over a million hectares with coffee were eradicated in an effort to reduce production and release new areas for the production of food crops. Depending on the quality and number of trees uprooted, farmers received compensation of 11 to 22 cents per tree (Henshal and Monsen, 1976). The eradication program was an attempt to increase the international price of coffee in order to maximize Brazilian revenues from the product, which had always been an important source of import financing. Since coffee production is extremely labor using, the eradication had serious repercussions on farm employment in the region.

The financial resources brought into the area in compensation for the eradicated coffee were to some extent invested in livestock for milk production. However, dairy cattle raising developed in a limited way in the Zona da Mata. The high cost of selected breeds, capital investment, specialized labor, feeding, and other items permitted economically efficient production only on the larger farms in the area (UFV, 1979; Leite, 1981).

The status of the Zona da Mata today is, by national or international standards, one of chronic poverty. The lack of employment opportunities, low incomes, and the poverty of the regional social infrastructure have already forced substantial migration toward the more dynamic centers of Brazil. Per capita income for the area in 1975 was equivalent to U.S. $250, well below the national poverty level determined by the World Bank as U.S. $340.[3,4]

To alleviate the chronic regional socioeconomic problems the State Government planners conceptualized the Integrated Rural Development Program of Zona da Mata (PRODEMATA). The program is sponsored by the World Bank and is operated in the region by several state agencies. The objectives and targets of this program as well as other information are provided in the following section.

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[3] Small farmers and sharecroppers of Zona da Mata are also worse off when compared to their peers in other poor regions of Brazil. In the 1972-73 crop year, for example, small farmers in the Zona da Mata and Campos das Vertentes (Minas Gerais) earned approximately U.S. $145 and U.S. $135, respectively. Those of Caninde (Northeast Brazil) and Vale do Ribeira (Sao Paulo) made about U.S. $160 and U.S. $180 in the same crop year. Sharecroppers' incomes in those regions were even lower, running from 14 to 40 percent of small farmers' incomes (Patrick and Carvalho Filho, 1975).

[4] The Gini coefficient for income distribution in the Zona da Mata region, computed from the PRODEMATA sample of 1976/77 is 0.64 according to an estimate by Leite (1981). For the state of Minas Gerais the Gini coefficient is 0.54.

The Integrated Rural Development Program for the Zona da Mata (PRODEMATA)

The objectives of PRODEMATA are to improve the living standard and incomes of small farmers in the Zona da Mata region. Specifically, it is intended (a) to increase farm production by expanding the area under cultivation and raising yields and (b) to expand and improve social services to farmers and the general rural population.

These objectives are to be achieved through four program components. The components of the project include

(a) Agricultural credit for crop and livestock production, reforestation, land reclamation, and rural electrification;

(b) Agricultural support services such as agricultural research, extension services, demonstration facilities, and education;

(c) Social infrastructure for health and education; and

(d) Administration, monitoring, and evaluation to the project.

The project was first initiated in June 1976. It has recently been extended for three more years to 1985. The total cost of the first phase of operations (5 years) was approximately U.S. $139 million.

The project component of interest to this study is credit. This component is a comprehensive credit program designed for small farm owners, sharecroppers, and medium farmers. It entails 60 percent of the project costs and is aimed at 25,000 small farm families. The supervised credit is provided through a well developed banking network, in cooperation with the strong technical assistance and supervision of the State Extension Service (EMATER). Credit is designed to cover short-term production requirements and long-term investment.

The production credit includes financing normal crop, livestock and forestry production, hired labor, and other inputs. In addition, consumption credit is provided to the smaller farms and sharecroppers. Investment loans for the establishment of fruit trees, forest, sugar cane, pasture and improvements, purchase of breeding stock, farming equipment, and rural electrification are also available.

About U.S. $1.2 million is allocated to EPAMIG for development of agricultural research in the region. This state agency is also in charge of evaluation and demonstration of technological improvements and the provision of technical assistance to EMATER training programs. Additional financing (about U.S. $10.3 million) is extended to EMATER for assistance to small farm owners in preparing farm plans, for the provision of supervisory services, and financing of subloan requests. The EMATER staff was enlarged by about 150 specially trained extensionists to deliver new technologies to small farm owners. Other project components involve the rural social plan. Medical care and education programs represent about 12 percent of the project costs. This will contribute to the development of health posts in the Zona da Mata and to the enlargement of the capacity of programs such as primary medical care, vaccination, sanitation, and nutrition. Educational program goals are to improve rural elementary education and to develop agricultural and technical programs. Other targets of the program are increased dissemination of knowledge in agricultural technology, rural organization, farm management, and so on.

Collection and Preparation of the Data

Sampling Procedure

A sample of PRODEMATA farmers was selected randomly to represent the population of landowners and sharecroppers in the Zona da Mata. The sample was taken in three of the most important regions administered by EMATER in the Zona da Mata: (a) Juiz de Fora, (b) Muriae and (c) Vicosa. In each region four municipalities were sampled: two of which are characterized by high population density and a significant number of producers of crops targeted by PRODEMATA; and two of which were randomly chosen.[5] Table 2-1 shows the 1976/77 data by administrative region.

The sample of property owners was drawn from the 1976/77 property tax rolls of the Instituto Nacional de Colonizacao e Reforma Agraria (INCRA). A random selection of 698 landowners was taken within the municipalities previously selected. The sampling units were stratified to follow closely the size distribution of farm properties in the respective sampling areas. Since no information for sharecroppers could be drawn from the tax files, the identification of sharecroppers to enter the sample was made by the farm owners who were sampled. A minimum of 12 sharecroppers for each municipality in the sample was selected to assure a sharecropper sample of nearly 50 in each administrative region. Each landowner and sharecropper was interviewed annually during the course of the PRODEMATA program.

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[5] The sample municipalities by region are (1) Juiz de Fora--Alto do Rio Doce, Juiz de Fora, Sao Joao Nepomuceno and Santos Dumont; (2) Muriae--Carangola, Leopoldina, Manhuacu and Muriae; (3) Vicosa--Ervalia, Ponte Nova, Raul Soares and Uba.

Table 2-1. The sample composition of PRODEMATA by class of farmers and administrative regions of Zona da Mata, Minas Gerais, in 1976/77

Class	Administrative Regions			Total Files	
	Juiz de Fora	Muriae	Vicosa	Before Purging	After Purging
Sharecroppers	52	52	49	153	129
Landowners:					
I. 0-10 Ha	64	94	74	232	112
II. 10-50 Ha	62	165	89	316	220
III. 50-100 Ha	24	50	24	98	59
IV. >100 Ha	18	25	9	52	19
Subtotal	168	334	156	698	410
Total	220	386	245	851	539

Source: Universidade Federal de Vicosa (UFV), Programa Integrado de Desenvolvimento da Zona da Mata, Minas Gerais. Primeiro Relatorio Anual de Avaliacao (UFV, 1979).

Those interviewees who did not meet specified consistency criteria in their responses were eliminated. The original data files were purged of inconsistent or incomplete questionnaires, resulting in a final sample with 539 respondents.

The Data

The data used in this study were obtained from farm level questionnaires designed to evaluate the impact of the PRODEMATA project. A broad set of information was collected and recorded by interviewers from the Department of Agricultural Economics at the University of Vicosa (DER/UFV). The data collected include all relevant socioeconomic information concerning the farming activities and family life of each member of the sample.

Data were collected from many farmers who participated in the PRODEMATA project and from a large group who did not. Data from this latter group may be used to establish a control group for the purpose of comparison.

The first survey was conducted in 1976/77, the year in which PRODEMATA activities were initiated. The data presently available cover 6 years from 1976/77 to 1981/82. This study is limited to the data collected in the 1978/79 and 1981/82 crop years.

The Study Database

The final samples for 1978/79 and 1981/82 contained 612 and 435 observations, respectively. Two questionnaires for sharecroppers with unusually high incomes in 1981/82 were eliminated from both samples. Then, a subsample was developed which included only the farmers who were interviewed in both crop years. This subsample of 432 farmers forms the database for this study (Table 2-2).

This unified subsample includes 182 farmers who are classified as "participants" in PRODEMATA because in at least one year they utilized credit from the official banking network tied to PRODEMATA and they received technical assistance provided by EMATER, the state extension service of Minas Gerais. "Non-participants" are those sample farmers who did not receive both credit and technical assistance from the program.

The information gathered from all questionnaires was assembled into two similar data sets which were used in this study: a family data unit and a farm management data unit.

Family Unit

This data set emphasizes data for the farm family. It excludes all information on areas operated by someone other than the interviewee. It also contains information about off-farm activities of the interviewee. The family unit data set will be used in the study of income distribution.

Farm Management Unit

The farm management unit data set is composed of data for the entire farm area under a single manager. This includes all data pertaining to the whole farm area under supervision of the interviewee.

Expenditure information reported in the questionnaires refers only to expenses incurred by the interviewee. Therefore, when sharecropping

Table 2-2. Sample composition of PRODEMATA farmers by tenancy class and participation, 1978/79 and 1981/82

Class	1978/79			1981/82		
	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
Sharecroppers	6[a] (3.3)[b]	60 (24.0)	66 (15.3)	4 (2.2)	57 (22.8)	61 (14.1)
Landowners:						
I. 0-10 Ha	24 (13.2)	60 (24.0)	84 (19.4)	24 (13.2)	58 (23.2)	82 (19.0)
II. 10-50 Ha	106 (58.3)	87 (34.8)	193 (44.7)	102 (56.0)	91 (36.4)	193 (44.7)
III. 50-100 Ha	33 (18.1)	27 (10.8)	60 (13.9)	36 (19.8)	28 (10.2)	64 (14.8)
IV. >100 Ha	13 (7.1)	16 (6.4)	29 (6.7)	16 (8.8)	16 (6.4)	32 (7.4)
Total Sample	182	250	432	182	250	432

[a] Number of farmers in tenancy class differ across 1978/79-1981/82 due to changes in the size of the farms.

[b] Numbers in parentheses are percentages.

was present, some adjustments had to be made in the data to estimate the total resources used in the farm management unit.

Three different cases may occur: (a) The interviewee is the farm owner and no sharecroppers are used, so that the farm owner provides all labor and all intermediate inputs. In this case the information reported by the interviewee is equal to the information for the farm management unit. For that reason, no adjustments are required. (b) The farm owner has part of the farm activities sharecropped with inputs provided by both the owner and the sharecropper.[6] In this case, the interviewee (farm-owner) data must be adjusted to include the value of labor and intermediate inputs provided by sharecroppers. (c) The interviewee is a sharecropper. In this case the intermediate inputs have to be corrected to account for the contributions of the farm owner.

Total farm management unit output figures were reported in the questionnaires even though the total inputs were not. Hence, adjustments for output were not required. Separate adjustments were made for labor and intermediate inputs.

Labor. In order to determine the total labor used on each farm management unit, it was necessary to estimate the quantity of labor used on the farm area cultivated by sharecroppers and add to that the quantity of labor reported by the farm owner (the interviewee). To estimate this, it was assumed that the labor per hectare used by sharecroppers is a function of the area sharecropped for each crop.[7] This relationship was estimated, via regression analysis, using sharecroppers data only. The set of regression equations which were used to estimate sharecropper labor contribution follow the specification

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[6] In the Zona da Mata sharecroppers generally provide all the labor and one half of the intermediate inputs in exchange for half of the crop (World Bank, 1976; UFV, 1979).

$$\ell n\ L_i = a_o + a_1\ \ell n\ A_i$$

where

L_i = quantity of labor used per hectare sharecropped on crop i;

A_i = area cultivated with crop i; and

a_o and a_1 = estimated parameters of the model.

The estimated labor/hectare ratios multiplied by the area sharecropped, provides an estimate of the amount of labor used on the sharecropped area. The set of regression equations used for this purpose is presented in Appendix B.

Estimated coefficients for tobacco in 1978/79 were not statistically significant. Therefore, corrections for labor used on tobacco were taken as the product of the average labor per hectare times the area being sharecropped. This same criterion was used for tobacco, coffee and sugar cane in 1981/82.

Intermediate inputs. To incorporate sharecropper or owner expenditures for intermediate inputs into total expenditures for the farm management unit the following adjustment formula was used.

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[7] Corn, rice, beans, corn-beans (intercropped), tobacco, sugar cane and coffee.

$$GT = G \left[\frac{A + B}{A + 0.5\ B} \right]$$

where

GT = total expenditure on intermediate inputs for the production unit;

G = input expenditure of the interviewee on the area cultivated by him;

A = area of the farm management unit cultivated by the owner; and

B = area of the farm management unit cultivated by the sharecropper.

The above adjustment process is valid for both cases where intermediate input corrections are needed. For example, if the interviewee is a sharecropper, then A equals zero. In this case, the expenditures declared by the interviewee are doubled for the farm management unit. In the case of a farm owner who has part of his land sharecropped, the correction factor will vary in proportion to the size of the areas farmed by the owner and the sharecropper.

CHAPTER III
CONCEPTUAL FRAMEWORK

This chapter develops a conceptual framework for analyzing the success of the PRODEMATA project in upgrading the conditions of the rural people of Zona da Mata. The success achieved in obtaining the objectives of increasing employment, stimulating farm output and increasing the participation of small farms and laborers in total income of the Zona da Mata depends on the nature of the changes induced in the production structure.

Changes in the production structure occur as a result of several and sometimes associated causes. It can mean changes in the use of productive resources induced through changes in the relative factor prices, institutional changes and/or dissemination of modern inputs and techniques, etc. Since those changes affect the structure of the farm production they change the pattern of demand for the resources, the composition of the output, and the pattern of the income distribution.

Some aspects of the technological change model are discussed throughout this chapter. Technological change affects income distribution in two ways. First, it can cause a change in factor shares, and second, it can affect the personal distribution of income, i.e., the distribution of income among the farm households.

The first three sections of this chapter contain a discussion of the economic problem of the Zona da Mata based on the neoclassical models of employment, distribution and technological change.

Sections four and five are dedicated to the concept of duality, applications, and properties of the cost functions. The last section focuses on the problem of the personal distribution of income.

Employment and Distribution in the Neoclassical Model

In the neoclassical model the firm's technology is completely described by the parameters of a production function which relates the maximum levels of output that can be obtained from alternative input combinations. Assuming perfect competition each firm will equate the value of marginal product of each resource to its respective input price in order to achieve allocative efficiency. Thus, relative market prices dictate the choice of production technique for producing a given level of output under the current technology.

The level of factor employment and the distribution of income among the resource owners can be deduced from the mathematical properties of the production function. For any production function that is homogeneous of degree one, the marginal products and average products of each factor are functions of the factor ratios. For example, decreases in the labor/capital ratio increase the marginal product of labor and decrease the marginal product of capital. Consequently, with the prices given and allocative efficiency in the product and input markets, the labor value of marginal product increases with decreases in the labor/capital ratio. A lower labor/capital ratio corresponds to higher value of marginal product of labor and higher output per capita. This is shown on the value marginal product curve for labor drawn in Figure 3-1. Given the labor force (L), if the capital level is increased, the labor/capital ratio

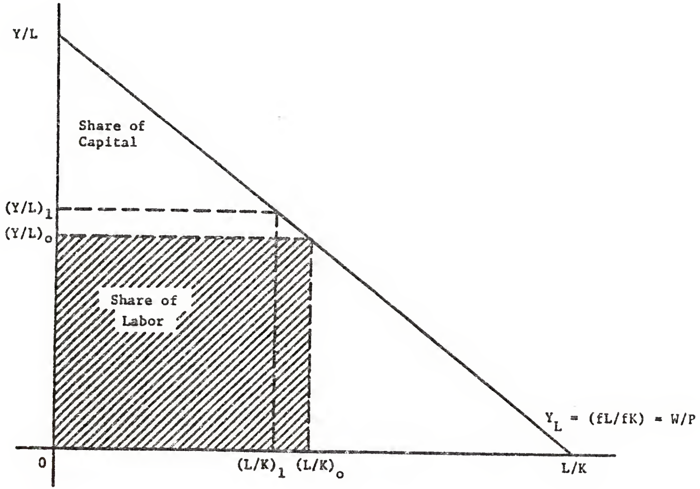

Figure 3-1. Marginal product of labor (Y_L) plotted as function of the labor capital ratios

decreases from $(L/K)_o$ to $(L/K)_1$. This increases the output per capita from $(Y/L)_o$ to $(Y/L)_1$. A similar effect might be caused by migration.

The behavior of the relative share of labor in the total output produced would depend on the elasticity of substitution as well as the change in the capital/labor ratio. A decrease in the labor/capital ratio would increase the relative share of labor if the elasticity of substitution is less than unity. Mathematically this can be expressed by the following equation as shown in Ferguson (1969).

$$ds = \frac{L}{K} \cdot (1 - \sigma) \cdot d(K/L)$$

where:

$$\sigma = \frac{d\ \ell n(K/L)}{d\ \ell n(f_L/f_K)}$$

dS = change in labor relative share

$d(K/L)$ = change in the K/L ratio

K = capital

L = labor

σ = elasticity of subsititution of capital for labor

f_L = marginal product of labor

f_K = marginal product of capital

This factor share model may be used to evaluate the economic growth process in underdeveloped areas. Incentives for capital formation promote development in the sense that a greater capital availability will, ceteris paribus, increase the productivity of labor, thereby generating increased income per capita. If the elasticity of substitution is, as it is commonly assumed to be for traditional economies, less than unity, then the relative share of labor would increase as the labor/capital ratio decreases.

The Economic Problem of the Zona da Mata

Chronic backwardness of the Zona da Mata is frequently attributed to a lack of capital. The incapacity of the large number of small farmers of the region to generate sufficient earnings to allow for reinvestment in farm activities has represented a bottleneck for the overall improvements of the agricultural sector of the region. As a result of past economic policies which were aimed at high increments of production in the short run, much of the institutional funds and technical services have been directed to the larger farmers. Therefore, the chances for small farmers to take advantage of new technologies and more profitable crop mixes were rather low. The inauguration of PRODEMATA has created better opportunities for the improvement of small farmers.

Economic research carried out in the region has suggested the economic feasibility of new technologies and alternative crop mixes for small farmers (Panagides and Ferreira, 1973; Cesal and Bandeira, 1973). In spite of the normative character of these studies, they seem to support the hypothesis that agricultural employment and income can be increased in the region if proper technologies are adopted by farmers.[1]

Much of the discussion concerning the effects of technological change centers (a) on the nature of technology, and (b) the environment in which technological development takes place (Gotsh, 1972). Most agricultural technologies are either mechanical or chemical-biological in nature. Mechanical technologies tend to be labor-saving and suited to large scale production. The chemical-biological technologies tend to be land-saving and either neutral or biased to small scale production (Hayami, 1982). It is postulated that land-saving and labor-using technologies best serve the growth problem of regions like the Zona da Mata. The labor-using technologies shift the labor marginal product curve outwards. For given factor prices, the employment of labor would increase relative to capital and the aggregate earnings of labor would increase if the elasticity of substitution is less than unity. However, increased equity in income distribution depends on other factors beyond the character of the technology. The distribution of factor ownership, personal characteristics such as education and skills, willingness to take risks, political power of farmers and biased decisions on the part of rural institutions are some of the reasons why income may be unequally distributed among farm households (Gotsh, 1972; Knight, 1976). Therefore, even if proper technologies exist, the increased participation of small farmers in the gains of new technologies may be negligible in the absence of effective mechanisms to redistribute productive resources.

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[1] Support of this hypothesis can be found in "Estudos sobre Regiao Agricola: Zona da Mata de Minas Gerais." Numerous studies summarized in this volume found that the introduction of appropriate

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enterprised mixes including fruits, coffee, forest, and others, coupled with new technologies permitted increases in the income level and greater absortion of family and hired labor in most of the typical farms. The impossibility of expanding cultivable land and a shortage of operating capital represented important constraints to further increments in incomes of small farmers. See, for example, Panagides and Ferreira (1973).

Many PRODEMATA programs, such as investments in social infrastructure, are expected to affect the well being of the population only in the long-run. However, the expansion of credit and technical assistance to small farmers may influence the status of farmers in a shorter period. Because of this it is postulated that PRODEMATA will have beneficial effects on employment, output, and income distribution within the study period. Previous research has suggested that integrated rural development projects like PRODEMATA are capable of producing such salubrious effects (Berry and Cline, 1979; Rask, 1977; Gotsh, 1972).

Technical Change in the Neoclassical Model

The economic consequences of technological change are illustrated in Figure 3-2. Each isoquant in the diagram represents various input combinations capable of producing a given level of output for a given technology. Movement of the isoquant towards the origin indicates technological change. If E represents the current technology, then firms producing on isoquants higher than E are said to be technically inefficient. In this situation producers are employing more resources than necessary to produce the level of output, given the technology available. Any point on isoquant E is technically efficient. However, given the factor price ratio, AB, only point H is economically efficient. Producers operating at this point equate the marginal rate of technical substitution in production to the factor price ratio.

Suppose there exists an available technology which permits the production of the same output level as represented in isoquant E at a lower cost. This situation is illustrated by isoquant F_o. For these

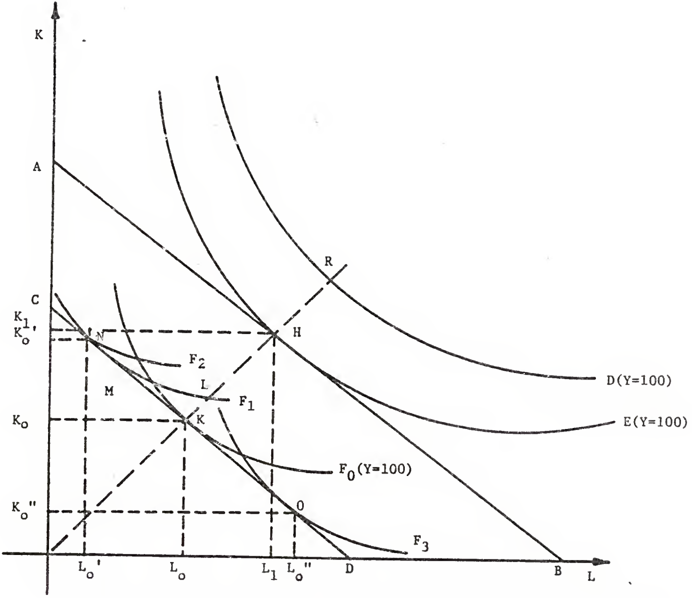


Figure 3-2. An illustration of shifts in the isoquant of a typical firm caused by technological change

adopters of the new technology there is a total reduction in labor and capital use represented by the amounts $(L_1 - L_o)$ and $(K_1 - K_o)$, respectively. The relative resource saving due to the new technology can be represented either by $(L_1 - L_o)/L_1$ or $(K_1 - K_o)/K_1$.

Technological changes are customarily classified as neutral and non-neutral. Assuming constant factor prices, neutral technological change corresponds to shifts in the production function over time in such a way that the capital/labor ratio is not altered. Non-neutral technological changes correspond to shifts which either diminish or increase the capital/labor ratio over time. Consider ray OR in Figure 3-2. Under conditions of constant factor prices, any changes from position H to points off ray OR represent non-neutral technological changes. Changes along ray OR define neutral technological changes. For example, the movement from H to O represents a labor using (or capital saving) technological change. In this case, the marginal product of labor increases in relation to the marginal product of capital. At constant factor prices, farmers increase labor usage per unit of capital. Mathematically this can be stated as

$$B = \frac{d(K/L)}{dt} \frac{1}{K/L} \begin{matrix} < \\ = \\ > \end{matrix} 0 \longrightarrow \begin{matrix} \text{L using or K saving} \\ \text{L neutral} \\ \text{L saving or K using} \end{matrix}$$

where B is the technologial change bias or the rate of change in the K/L ratio through time.

One can also express technological change bias in terms of each factor's share in total costs. If S_i is the change in the share of factor i attributed to a technological change and α_i is the share of factor i, then

$$B_i = \frac{d\alpha i}{dt}\frac{1}{\alpha_i} \begin{matrix} < \\ = \\ > \end{matrix} 0 \longrightarrow \begin{matrix} \text{i saving} \\ \text{i neutral} \\ \text{i using} \end{matrix}$$

In Figure 3-2 consider the change from point H to point N. The change in the share of labor in total costs is given by $\frac{L_1 W}{C_1} - \frac{L_0' W}{C_0}$ and the change in the share of capital is given by $\frac{K_1 r}{C_1} - \frac{K_0' r}{C_0}$ This represents an increase in the share of capital and a decrease in the share of labor in relation to the total cost, at constant factor prices. Thus, the movement from H to N characterizes a capital using (labor saving) technology, as previously defined.

The Concept of Duality

Traditionally, cost and demand structure estimates have been obtained through the estimation of a production function in which the output level is dependent on a given set of input quantities which are assumed to be independent. Analytical solution of the first order equations permits the derivation of demand, cost functions, and output supply. Frequently, this procedure is troublesome and presents difficulties spanning data collection, econometric estimation, and other problems (Yotopoulos and Lau, 1979). The possibility that the firm's output and input determination are simultaneous suggests that the input levels may not be truly independent variables (Parks, 1971). In addition, the frequently high multicollinearity among the input combinations leads to problems of instability of the estimates (Binswanger, 1974a).

Two alternative approaches are to estimate the cost functions and the factor demand curves directly or to estimate a profit function using the concept of duality. In the recent economic literature the duality relationships between the cost function and the production function have been increasingly used for purposes of empirical estimation for analyses of production and distribution. Unlike the traditional approach, which may lead to simultaneous equation biases and inconsistencies, these formulations, under the standard assumptions, lead to statistically consistent estimations of the parameters (Yotopoulos and Lau, 1979). Under certain regularity conditions the parameters of the cost function correspond to the parameters of the production function. Once the cost function is estimated, the demand structures and factor shares may be derived using the concepts of duality.

The analysis of the production structure on the basis of cost functions is advantageous in many aspects. Homogeneity of degree one does not have to be imposed on the production process for arriving at the estimated equations. The linear homogeneity of factor prices in cost functions does not imply homogeneity of production. A two-fold increase in factor's price doubles the cost but does not affect the factor ratios. Additionally, estimation biases are avoided by using the prices as independent variables rather than physical quantities of the inputs, which are truly endogeneous variables at the firm level. Estimation of the elasticities is less subject to errors which probably arise when the production approach is used (Binswanger, 1974a).

The cost and production function relationships empirically obtained are unique. Under the cost minimization assumption they are simply two different but equivalent views of the same thing, as demonstrated in Nerlove (1965), Schmidt and Lovell (1979), and others.

The first empirical application of the duality between cost and production function was Nerlove's classic study of economies of scale in electric power generation in 1965, in which he estimated a cost function dual to a generalized Cobb-Douglas production function. Other harbingers of the use of profit and cost functions include McFadden (1966), Shephard (1953), and Diewert (1971). Diewert used the Hotelling and Shephard's duality theorem to obtain a system of demand equations derived from the cost functions which are linear in the technological parameters. This greatly facilitates econometric estimation procedures. His work led to the generalized Leontief production function. Parks (1971), used a linear version of the Leontief cost function to study the price responsiveness of factor utilization in the Swedish manufacturing industry using a temporal series for the period 1870 to 1950. The flexibility of the functional form allowed tests of constant returns to scale, nonhomotheticity of the production process, factor augmenting technological biases, and the derivation of substitution and factor demand elasticities. Binswanger (1974a, 1974b) used a translog function to measure the elasticities of factor demand and substitution elasticities for state data of the U.S. agricultural sector. The function was also used to measure technological change biases in a many-factor production function analysis. His methodology allowed the isolation of the effects of biased technological change on the factor shares from the effects of factor substitution induced by price changes.

Lopez (1980) used a Parks' (1971) specification of the Leontief function to study the structure of production and the derived demand functions for inputs in Canadian agriculture. He estimated a system of factor demand equations and showed through the analyses of the integrability condition that an aggregate cost function exists for the Canadian agricultural sector and, therefore, an aggregate production function exists. He also confirmed the hypothesis that growth in Canadian agriculture was associated with relative factor price behavior and expansion in the output level, rather than with biased technological progress. Other applications of the cost functions were recently presented by Ray (1982), Ball and Chambers (1982), and Chambers (1982), among others.

Properties of Cost Functions

The concept of cost functions, as described in standard economic theory, links the cost of production to input prices and the level of output. The cost function defines the minimum cost of producing a given level of output at those input prices, given the technology. Assuming that producers behave as cost minimizers and prices are given, then the cost function is defined as

$$C = C(Y,P) = \min \left[PX \mid Y(X) \geq Y \right]$$

where C is the least cost for producing the predetermined output Y, at given prices P. "The minimum exists and the cost function has a non-negative, finite value if the output bundle can be produced with a given technology and if input prices are strictly positive" (McFadden, 1966, p. 5).

The firms are generally better able to specify the minimum costs of production of a given output bundle than to specify the physical quantities of inputs needed to achieve that output. There is a one to one correspondence between the two sets defined by the production function and the cost functions (McFadden, 1978). If this is so, the cost functions carry all the relevant characteristics of the technology and they represent a useful device for econometric analysis of production. It is insured that the cost function describes the underlying technology (the farmer's production function), if the cost function satisfies some regularity conditions, described by the following properties:

(1) If $C(Y, \phi P) = C(Y,P)$, where ϕ is a positive scalar, then $C(Y,P)$ is homogeneous of degree one in prices, i.e., an increase in all input prices by the amount of ϕ requires an increase equally proportional in the firm's outlays in order to produce the same output level.

(2) The cost functions are non-negative at all prices and output levels, non-decreasing in output, and monotonically increasing in prices.

(3) The cost function is concave with respect to prices: $[C(Y, \phi P_1 + (1-\phi)P_2] \geq [\phi C(Y,P_1) + (1-\phi)\ C(Y,P_2)]$

(4) The cost function is continuously differentiable for positive input prices.

The cost function represents constant returns to scale if and only if it can be decomposed in the following manner:

$$C(Y,P) = Y\,\overline{C}(P)$$

where $\overline{C}(P)$ is the unit cost function and it is non-negative, linear homogeneous, non-decreasing and a concave function of prices.

Homothetic functions are important in applied analysis of production. Cobb-Douglas and constant elasticity of substitution production functions constitute special cases of homothetic production functions (Chambers, 1982). If the production function is homothetic, it can be written as

$$\Psi(Y) = f^{*}(\chi)$$

where $f^{*}(\chi)$ is a linearly homogeneous function and $\Psi(Y)$ strictly increases from zero to infinity (Hanoch, 1978). The cost function will represent a homothetic production process if and only if it can be decomposed as

$$C(Y,P) = \Psi(Y)\,\overline{C}(P),$$

where C is a continuous, non-decreasing function of the output level (Diewert, 1971).

Each cost function is related to the cost-minimizing input demand functions through the partial derivatives with respect to the input prices. Where they exist, such derivatives describe the demand equations for the factors (Lopez, 1980). This property is also known as the Hotelling-Shephard's lemma. Given the cost function:

$$C^* = C^*(Y,P)$$

where

P = a vector of input prices

Y = the output level

C^* = total minimizing cost of producing Y units as a function of P

then

$$\frac{\partial C^*(Y,P)}{\partial P} = X^*(Y,P)$$

where $X^*(.)$ is the demand equation for any factor. Writing this equation in elasticity form leads to the factor share of i, represented by α_i.

$$\alpha_i = \frac{\partial C^*}{\partial P}\frac{P}{C^*} = \frac{X^*(Y,P)\ P}{C^*}$$

For a homothetic production structure note that the factor shares do not depend on the output level since

$$C^* = \Psi(Y)\ C^*(P)$$

$$\alpha = \frac{\partial C^*}{\partial P}\frac{P}{C^*} = \frac{\partial\ \ell n\ C^*}{\partial\ \ell n\ P}$$

which is independent of the output level.

If the cost function is homogeneous of degree one in factor prices, it follows from Euler's theorem that the demand equations will be homogeneous of degree zero, i.e., the multiplication of factor prices by the same constant will not affect the demand for each of the factors and the respective factor shares.

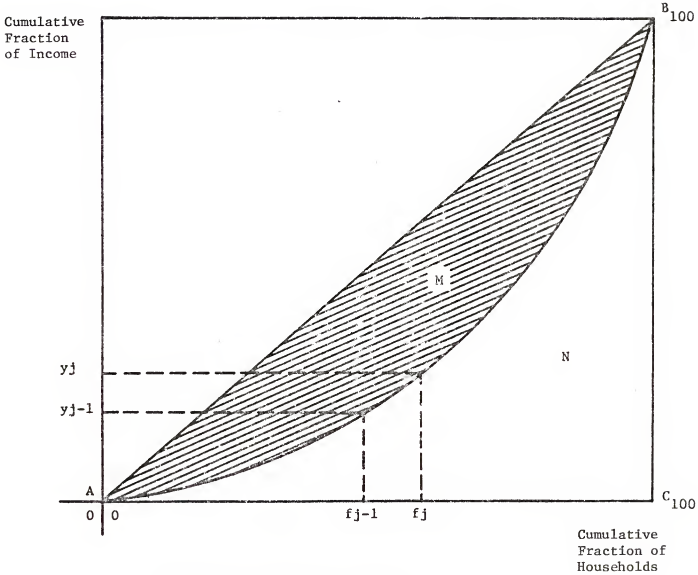
Income Distribution

Analyzing the impact of PRODEMATA on the distribution of incomes will distinguish which groups of farmers have benefitted most from the program. In this framework, the criterion to be followed for comparing and assessing the inequalities within the groups of farmers assisted by PRODEMATA are the Lorenz curve and Gini coefficient.

The Lorenz Curve

A Lorenz Curve relates the cumulative percentage of income receivers, plotted from 0 to 100 on the horizontal axis to the cumulative percentage of total income received, plotted on the vertical axis. Figure 3-3 shows a Lorenz curve. The shaded area in the diagram is called the concentration area. For a perfectly egalitarian society, the Lorenz curve will be a 45 degree straight line connecting the points (0,0) and (100,100) at the two vertices of the diagram. In this case, each individual receives his corresponding share in income, i.e., the first 10 percent of the population receives 10 percent of the income, and so on. When perfect inequality occurs, the Lorenz curve degenerates to a pair of perpendicular straight lines. Lorenz curves based on empirical data generally are situated between the extreme cases of complete inequality and perfect equality and cut the points (0,0) and (100,100), as shown in Figure 3-3. The greater the concentration in the income distribution the larger the concentration area.

Absolute normative statements about Lorenz curves are impossible, since one can not say what the income distribution should be. Statements on this matter are mere value judgements.


Cumulative Fraction of Income
B 100
M
N
yj
yj-1
A
0
0
fj-1
fj
C 100
Cumulative Fraction of Households

Figure´3-3. The Lorenz curve

However, comparative, objective statements can be made. A set of preference rules which may be used for making such comparisons can be developed based on the relative position of the curves: (a) if two Lorenz curves coincide then the distributions are judged to be equally unequal; (b) if one Lorenz curve lies entirely above another than the first distribution is judged to be more equal; (c) if two Lorenz curves cross, then the assessment of inequality comparisons only can be made with additional information, if at all.

Gini Ratio

Several unidimensional measures of relative income inequality based on the income distribution data of Lorenz curves exist. The most common of these is the Gini ratio which compares the area of concentration with the maximum possible inequality area (ABC in Figure 3-3). The ratio of the concentration area (M) to the total area (M+N) approaches unity as concentration increases and approaches zero as the concentration decreases. A formula for the Gini coefficient can be derived as follows:

The concentration area "M" is given by:

$$M = 1/2 - \sum_{j=1}^{K} (f_j - f_{j-1}) (Y_j + Y_{j-1})/2$$

where

f_j = cumulative proportion units

Y_j = cumulative fraction of income

K = number of income classes

then the Gini ratio $GC = \frac{M}{M+N}$ is given by

$$GC = \frac{\frac{1}{2} - \sum_{j=1}^{K} (f_j - f_{j-1})(Y_j + Y_{j-1})/2}{1/2}$$

$$GC = 1 - \sum_{j=1}^{K} (f_j - f_{j-1})(Y_j + Y_{j-1})$$

The conceptual model developed in this chapter will be used for analyzing the inpact of PRODEMATA on small farmers engaged in this program. The analysis that follows is motivated by the need for more knowledge about the effect of credit on farm income and the demand for productive resources. The cost functions will be used in the next chapter for an analysis of factor employment using participant and non-participant data. The following chapter deals with changes in the income level and in the income distribution. Gini coefficients and Lorenz curves will be used for comparative purposes when assessing the changes of the income distribution in the Zona da Mata during the PRODEMATA program.

CHAPTER IV
EVALUATION OF THE IMPACT OF PRODEMATA ON FACTOR EMPLOYMENT

The hypothesis that PRODEMATA substantially increased modern input consumption and labor employment within the Zona de Mata will be tested in this chapter. These hypotheses will be tested by comparing systems of demand functions for participants and non-participants in the PRODEMATA program. These demand functions are derived from the estimated parameters of cost functions estimated for each sub-sample.

The Cost Function

Assume that PRODEMATA farmers behave rationally and that they minimize the variable costs of production subject to the existing technology and a set of fixed costs. Then the indirect variable cost function (hereafter called "the cost function"), may be written as:

$$C_i = g(Y_i, P_{ij}) \qquad \begin{array}{l} i = 1, \ldots, m \\ j = 1, \ldots, k \end{array} \qquad (1)$$

where:

C_i = the observed cost of variable inputs for farmer i;

P_{ij} = the observed price of input j for farmer i; and

Y_i = the observed level of output for farmer i.

One major problem in the econometric estimation of the cost parameters in a many factor model is the choice of the functional form (Parks, 1971). The problem is to find a specification sufficiently rich in the parameters which is simultaneously consistent with economic theory. Some functional forms (e.g., Leontief and translog) are desirable because they do not imply constancy of the factor substitution elasticities. Others, like the Cobb-Douglas, are more restrictive. Several different specifications for the cost functions were attempted in this study.

The Leontief Specification

The first attempt was a generalized Leontief formulation similar to that used by Parks (1971). The Leontief cost function is of the form

$$C(Y, P) = Y \sum_{i=1}^{K} \sum_{j=1}^{K} A_{ij} P_i^{\frac{1}{2}} P_j^{\frac{1}{2}} + Y^2 \sum_{i=1}^{K} B_i P_i$$

where:

C = minimized total variable cost;

Y = output level;

P_i, P_j = factor prices; and

A_{ij} and B_i = parameters of the cost function.

The parameter estimates for two versions of the Leontief function fitted to pooled PRODEMATA data for 1978/79 are presented in Table 4-1. The results were not acceptable since most of the parameters estimated were not statistically significant. Additionally, some coefficients violate the concavity condition ($A_{ij} \geq 0$ for all $i \neq j$). However, all the required properties of a cost function may still hold locally, i.e., at each of the observed sample points (Woodland, 1975).

Table 4-1. Parameter estimates of the Leontief cost function obtained from pooled PRODEMATA data, 1978/79

Parameters[a]	Estimated Parameters (Model I)	Estimated Parameters (Model II)
$W_L \cdot W_F$	0.008691 (0.174)[b]	0.0076450 (0.154)
$W_D \cdot W_F$	0.000272 (0.017)	-0.0047740 (0.394)
$W_D \cdot W_L$	-0.003658 (0.908)	-0.0040610 (1.04)
$W_S \cdot W_F$	0.109951 (0.224)	0.2845930 (0.583
$W_S \cdot W_D$	0.030733 (0.786)	0.0407450 (1.047)
$W_S \cdot W_L$	-0.115425 (0.667)	-0.1124470 (0.646)
W_S	0.621405 (0.296)	0.0886320 (0.042)
W_L	0.021113 (1.141)	0.0241000 (1.307)
W_F	-0.075562 (0.925)	-0.1313990 (1.553)
W_D	-0.000336 (0.247)	-0.0001373 (0.093)
$W_L \cdot Y$	---	-0.0000070 (0.795)
$W_F \cdot Y$	---	0.0001620 (2.629)
$W_D \cdot Y$	---	8.44427E-07 (0.765)

Table 4-1—Continued

Parameters[a]	Estimated Parameters (Model I)	Estimated Parameters (Model II)
$W_S \cdot Y$	---	-0.001100 (1.537)
$\bar{R}^2$	46.38	50.22
F	53.567	44.807

[a] Dependent variable = C/Y; C = variable cost; W_L = wage rate; W_F = price of chemical fertilizer; W_D = price of draft animal services; W_S = price of seeds (proxy); Y = output.

[b] Numbers in parentheses are t-values.

The Translog Specification

A second set of attempts was made using a translog specification as formulated in Binswanger (1974a). The functional specification of the translog is written as

$$\ell n\ C = \ell n\ \alpha_o + \alpha_y\ \ell n\ Y + \sum_{i=1}^{K} \alpha_i\ \ell n\ P_i + \tfrac{1}{2} \sum_{i=1}^{K} \sum_{j=1}^{K} \alpha_{ij}\ \ell n\ P_i\ \ell n\ P_j + \sum_{i=1}^{K} \alpha_{iy}\ \ell n\ P_i\ \ell n\ Y \qquad (3)$$

where the α coefficients are the cost function parameters to be estimated and the variables are defined as in equation 2. The results obtained from fitting the translog cost function to the pooled PRODEMATA data are shown in Table 4-2. As with the Leontief form, the results were not satisfactory because many coefficients were not statistically different from zero. Economic theory provides no a priori expectations about the signs in the case of the translog function. Since most of the coefficients were insignificant, concavity and positivity were not tested.

The presence of a large number of parameters that were not statistically significant in the translog and Leontief function suggests the presence of multicollinearity problems, presumably due to the high number of parameters to be estimated simultaneously. Similar estimation problems with the translog function were reported by Ray (1982). One technique that is capable of reducing the parameters to be estimated simultaneously is to estimate directly the factor share equations.

Table 4-2. Parameter estimates of the translog cost function obtained from pooled PRODEMATA data, 1978/79

Parameters[a]	Estimated Parameters
INTERCEPT	-4.635100 (2.272)[b]
$\ell n\ W_F$	-0.303192 (0.282)
$\ell n\ W_L$	0.742528 (1.157)
$\ell n\ W_D$	0.560663 (0.861)
$\ell n\ Y$	0.841897 (2.033)
$\ell n\ W_F \cdot \ell n\ Y$	-0.105319 (1.533)
$\ell n\ W_L \cdot \ell n\ Y$	-0.032820 (0.381)
$\ell n\ W_D \cdot \ell n\ Y$	0.008791 (0.221)
$\ell n\ W_L \cdot \ell n\ W_L$	0.202637 (0.807)
$\ell n\ W_F \cdot \ell n\ W_F$	0.190735 (1.263)
$\ell n\ W_D \cdot \ell n\ W_D$	0.104307 (1.764)
$\ell n\ W_F \cdot \ell n\ W_L$	0.294985 (0.901)
$\ell n\ W_D \cdot \ell n\ W_L$	-0.226104 (1.206)

Table 4-2—Continued

Parameters[a]	Estimated Parameters
$\ell n\ W_D \cdot \ell n\ W_F$	-0.046203 (0.342)
R^2	66.99
F	107.36

[a] Dependent variable = C; C = variable cost; W_F = price of chemical fertilizer; W_L = wage rate; W_D = price of draft animal services; Y = output.

[b] Numbers in parentheses are t-values.

Translog Share Equations

The parameters of the translog cost function can also be estimated indirectly in the form of its first derivatives which, by Shephard's lemma are the factor shares. A system of share equations derived from equation (3) was estimated subject to linear homogeneity and additivity restrictions as specified in Binswanger (1974a) and Berndt and Wood (1975). The form of the share equation for the i^{th} factor share is

$$S_i = \frac{\partial C}{\partial P_i} = m_i + \sum_{j=1}^{K} m_{ij} \ln P_j + m_{iy} \ln Y + e_i \tag{4}$$

where:

S_i = cost share of factor i; $i = 1, \ldots, K$

P_j = the price of factor j; $j = 1, \ldots, K$

Y = output; and

m_i, m_{ij}, and m_{iy} are the parameters to be estimated.

The error term attached to each share equation was assumed to be normally distributed with a mean equal to zero and a constant variance. Since it is probable that the error terms are correlated across equations, Zellner's seemingly unrelated regression procedure was used to estimate the share equations as a system.[1] The production factors considered in the share equations were fertilizer, labor, draft animal and mechanized services.

Because the factor shares sum to unity, only n-1 equations were estimated. Therefore, the cost parameters were actually estimated only for the cost share equations of labor, chemical fertilizer, and draft animals. The parameters of the mechanized services equations were calculated based on the additivity properties.

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[1] A detailed discussion of this estimation procedure is found in Zellner (1962).

A translog function is well behaved if it is concave and if the input shares are positive. The estimated share equations (Table 4-3) satisfy the positivity condition. However, the own-price elasticities derived from the estimated factor share equations did not have the expected signs, implying that the derived translog cost functions are not concave in the range of the observed prices. Consequently, efforts to estimate a translog function were abandoned.

The Cobb-Douglas Specification

In an effort to resolve the multicollinearity problem, a Cobb-Douglas specification for the cost function was formulated. The mathematical specification of this function (Nerlove, 1965) is

$$C = KY^{\alpha_y} \prod_{j=1}^{K} P_j^{\alpha_j} \tag{5}$$

where K is the intercept, α's are parameters to be estimated and the variables are defined as before. The Cobb-Douglas model may be estimated as

$$C = KY^{\alpha} P_L^{\alpha_L} P_F^{\alpha_F} P_M^{\alpha_M} P_D^{\alpha_D} e^{\mu} \tag{6}$$

A homogeneity restriction can be directly imposed on the cost function by normalizing it with one of the input prices. Consequently, the derived demand functions will be homogeneous of degree zero in the

Table 4-3. Parameter estimates of the factor share equations derived from the translog cost function, obtained from pooled PRODEMATA data, 1978/79

Factors	Fertilizer	Labor	Draft	Machinery	Output	Intercept
Fertilizer	0.17021 (6.95)[a]	-0.11875 (4.81)	-0.02506 (3.08)	-0.0264	0.02969 (4.24)	0.41565 (5.08)
Labor	-0.11875 (4.81)	0.18920 (6.33)	-0.05383 (5.84)	-0.01662	-0.03819 (4.88)	0.57345 (6.18)
Draft	-0.2506 (3.08)	-0.05383 (5.84)	0.07956 (14.10)	-0.00067	0.00011 (0.05)	-0.08149 (2.60)
Machinery	-0.0264	-0.01662	-0.00067	0.04369		

[a] Numbers in parentheses are t-values.

factor prices. It makes no difference which price is used to normalize the equation (Schmidt and Lovell, 1979). If (6) is normalized on the price of animal services and expressed in logarithms, then the estimated form would be

$$\ell n\ (C/P_D) = \ell n\ K + \alpha_y\ \ell n\ Y + \alpha_L\ \ell n\ (P_L/P_D) + \alpha_F\ \ell n\ (P_F/P_D) + \alpha_M\ \ell n\ (P_M/P_D) + \mu \qquad (7)$$

where all variables are defined as before and μ is the disturbance or error term. It is assumed that μ is normally distributed with an expected mean of zero and a constant variance. The disturbance term accounts for errors in cost minimization by each sample observation and/or measurement errors.

Limitations of the Cobb-Douglas cost function. The Cobb-Douglas cost function presents some theoretical limitations. Changes in factor prices and in the output level do not affect the factor shares, because the elasticities of factor substitution are unitary. That is, changes in factor prices lead to opposite but proportional changes in input use such that the factor shares remain constant. Finally, complementarity between factors is not possible. Given these pecularities of this functional form assessments of the effect of changes in technology on the behavior of the factor usage can only be made on the basis of changes in the intercept of the cost function and changes in the cost parameters themselves.

The Cobb-Douglas estimates. The estimates obtained when using the Cobb-Douglas function were, from a statistical point of view, better than estimates obtained with the other functions (Tables C-1 through C-14 in Appendix C). The coefficients of the Cobb-Douglas form of the cost functions were all positive. This indicates that the estimated cost functions are increasing functions of the input prices, satisfying the monotonicity property of the cost functions. Thus the cost share for each input is positive. Consequently, the implied own-price elasticities derived from the cost functions carry the expected negative signs. Since the statistical results are consistent with a priori expections based on economic theory, the Cobb-Douglas specification were utilized in the remaining analysis.

Hypothesis Testing

The estimates of Cobb-Douglas cost functions were used to test formally the hypotheses that PRODEMATA induced changes in the production structure of small farmers in the Zona da Mata. The availability of cross-sectional data for the 1978/79 and 1981/82 crop years allows tests of both time series and cross-sectional hypotheses. If PRODEMATA has affected the production structure significantly then the cross-sectional analysis should show significant differences in the estimated demand parameters of participants and non-participants. On the other hand, time series analyses test the stability of the parameters through time. These tests will determine if the participants of the program have experienced some sort of technological progress as a result of PRODEMATA. The specific hypotheses to be tested in this chapter can be restated as follows:

Cross-Sectional

The production technology of participants and non-participants of PRODEMATA is characterized by different factor demand structures.

Time Series

The participant demands for productive resources have grown at a faster rate than for non-participants.

The set of hypotheses to be tested in this chapter is illustrated in Figure 4-1. The hypotheses concerning the equality of the demand parameters between participants and non-participants of PRODEMATA will be tested separately for the 1978/79 and the 1981/82 cross-sectional data (as shown by the dotted, horizontal lines in the chart). The stability of the demand parameters through time will be tested for both groups (as shown by the solid, vertical lines).

Tests of Validity of Restrictions

A restricted model is estimated assuming that participant and non-participant production technologies are described by a single demand function. Unrestricted models are estimated assuming that participant and non-participant demands for resources are not identical. Thus, the restricted and unrestricted models constitute the null and alternative hypothesis, respectively.

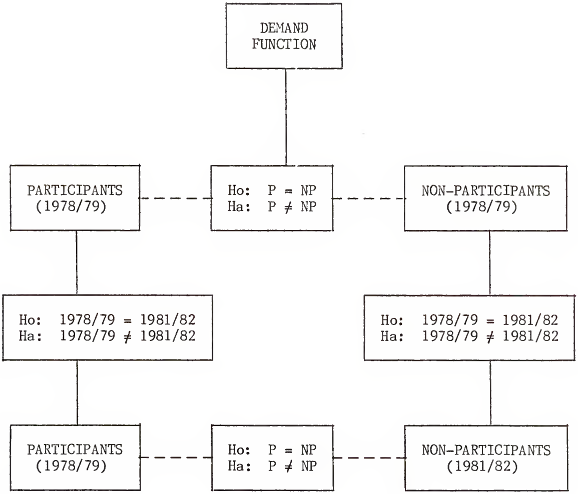

Figure 4-1. Hypotheses setting

The Test Statistic

The test statistic[2] is distributed as $F_{(R,N-K)}$ and calculated by:

$$F_{R,N-K} = \frac{(RSSE - USSE)/R}{USSE/N-K}$$

where

RSSE = restricted sum of squared errors;

USSE = unrestricted sum of squared errors;[3]

R = number of restrictions imposed on the the restricted models;

N = $n_1 + n_2$ = total number of observations; and

K = number of parameters including the intercept.

The null hypothesis is rejected whenever the calculated F ratio, with R degrees of freedom in the numerator and N-K in the denominator is larger than the appropriate table F values. If the null hypothesis is true, then the unrestricted models estimated from unpooled data would not increase explanation over the restricted models. As a result the squared sum of errors would not diminish significantly causing the computed F ratio to be small, which would lead to the non-rejection of the null hypothesis.

Cost Function Shifts

Before testing the derived demand parameters analogous tests were conducted for the cost functions. The cost structures were found to be equal in 1978/79 and unequal in 1981/82. For participants of PRODEMATA the cost parameters remained stable between 1978/89 and 1981/82. For non-participants the intercept of the cost function shifted downwards. As shown in the next section, the results were entirely consistent with those obtained when dealing with the demand parameters. The information used for the test statistic is presented in Table 4-4. The regressions are shown in Tables C-1 and C-4 of Appendix C.

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[2] For details see Chow (1960).

[3] The unrestricted sum of squared errors is equal to SSE (model 1) + SSE (model 2), where 1, 2 refer either to participants and non-participants or 1978/79 and 1981/82.

Induced Factor Demand Shifts

Cross-Sectional Shifts

The cost function estimates may be used to test the hypothesis that the demand functions derived for participants and non-participants of PRODEMATA are equal. If the system of demand functions derived for the two comparison groups do not differ then it may be inferred that the production technology of participants and non-participants is the same. Operationally, this is equivalent to testing the null hypothesis that the demand parameters estimated with participant and non-participant data are equal. The procedure followed for this purpose is described in Appendix C.

To test the above mentioned hypotheses restricted and unrestricted OLS estimates of the Cobb-Douglas cost functions, as described in Appendix C, were obtained for 1978/79 and 1981/82. The restricted estimates were generated by estimating the cost functions using pooled data for each year's estimate, assuming that the demand parameters are equal. The unrestricted estimates were estimated separately for the participants and non-participants in each year, assuming that the

Table 4-4. Statistical tests of the equality and stability of the cost function parameters, 1978/79, 1981/82, and across 1978/79-1981/82

	Degrees of Freedom[a]	Sample Size	F-Values	Critical Values of F	
				0.01	0.05
	Participants and Non-Participants			$F_{5,\infty}$ = 3.02	2.21
1978/79	5,420	430	1.67		
1981/82	5,418	428	2.52*		
	Across 1978/79-1981/82				
Participants	5,353	363	1.57		
Non-participants	5,485	495	4.35**		

[a] Degrees of freedom for the F-test with the number of restrictions in the numerator and N-K in the denominator.

*Significant at 0.05 probability level.

**Significant at 0.01 probability level.

demand parameters are different. The restricted and unrestricted estimates were tested to determine if there were a statistically significant difference between the two estimates. The estimated regression equations used for the development of the cross-sectional tests are found in Appendix C. The F statistics are reported in Tables 4-5 to 4-7.

On the basis of these F tests there is no evidence from the 1978/79 data that the demand equations derived from the participant and non-participant data have different intercepts or slopes. The results obtained using the 1981/82 data revealed that participant and non-participant demands for labor and mechanized services do not differ significantly. However, the intercept terms of the participant and non-participant demand for chemical fertilizer are statistically different.

Time Series Shifts

If the estimated demand parameters derived from the participant cost functions are not significantly different between 1978/79 and 1981/82 then the credit extended by PRODEMATA has had little impact on the demand for factor services. Conversely, a demand shift would imply that the desired shifts in factor demand have been achieved.

The stability of the factor demand was tested using an analysis of covariance test to compare restricted estimates from data pooled over time for participant and non-participants separately.
The restricted parameters were estimated for participants and non-participants for each year.

Table 4-5. Statistical tests of the equality of the intercept and slope in 1978/79 and 1981/82 and of the stability of intercept and slope across 1978/79-1981/82, demand for labor

	Parameters	Degrees of Freedom[a]	Sample Size	F-Values	Critical Values of F 0.01	Critical Values of F 0.05
	Participants and Non-Participants				$F_{2,\infty}$ = 4.61	3.00
1978/79	INTERCEPT	2,420	430	1.270		
1978/79	SLOPE	1,420	430	0.006	$F_{1,\infty}$ = 6.63	3.84
1981/82	INTERCEPT	2,418	428	1.290		
1981/82	SLOPE	1,418	428	0.281		
	Across 1978/79-1981/82					
Participants and non-participants (pooled)	INTERCEPT	2,848	858	1.670		
	SLOPE	1,848	858	1.150		

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[a] Degrees of freedom for the F-test with the number of restrictions in the numerator and N-K in the denominator.

Table 4-6. Statistical tests of the equality of the intercept and slope in 1978/79 and 1981/82 and of the stability of the intercept and slope across 1978/79-1981/82, demand for mechanized services

						Critical values of F	
	Parameter	Degrees of Freedom[a]	Sample Size	F-Values		0.01	0.05
	Participants and Non-Participants				$F_{2,\infty}$ =	4.61	3.00
1978/79	INTERCEPT	2,420	430	0.740			
1978/79	SLOPE	1,420	430	0.046	$F_{1,\infty}$ =	6.63	3.84
1981/82	INTERCEPT	2,418	428	1.370			
1981/82	SLOPE	1,418	428	0.070			
	Across 1978/79-1981/82						
Participants and non-participants (pooled)	INTERCEPT	2,848	858	1.790			
	SLOPE	1,848	858	0.100			

[a] Degrees of freedom for the F-test with the number of restrictions in the numerator and N-K in the denominator.

Table 4-7. Statistical tests of the equality of the intercept and slope in 1978/79 and 1981/82 and of the stability of the intercept and slope across 1978/79-1981/82, demand for chemical fertilizer

	Parameter	Degrees of Freedom[a]	Sample Size	F-Values		Critical Values of F 0.01	Critical Values of F 0.05
Participants and Non-Participants					$F_{2,\infty}$ =	4.61	3.00
1978/79	INTERCEPT	2,420	430	2.52	$F_{1,\infty}$ =	6.63	3.84
1978/79	SLOPE	1,420	430	0.02			
1981/82	INTERCEPT	2,418	428	3.14*			
1981/82	SLOPE	1,418	428	0.05			
Across 1978/79-1981/82							
Participants	INTERCEPT	2,353	363	2.42			
Participants	SLOPE	1,353	363	0.04			
Non-participants	INTERCEPT	2,485	495	6.07**			
Non-participants	SLOPE	1,485	495	1.21			

[a] Degrees of freedom for the F-test with the number of restrictions in the numerator and N-K in the denominator.

*Significant at 0.05 probability level.

**Significant at 0.01 probability level.

Statistical tests to detect factor demand shifts over time led to the conclusion that the participant demand function remained stable during the 1978/79 to 1981/82 period. The same occurred with non-participants except in the case of the demand for chemical fertilizer. In this latter case the intercept term shifted downward by 43 percent in 1981/82 compared to 1978/79 (see Appendix C for the regresion equations and Tables 4-5 to 4-7 for the statistical tests).

Summary

Based on the statistical results obtained, it can be asserted that the production technology of the participants of PRODEMATA was stable between 1978/79 and 1981/82. In other words, there was no perceptible change in the character of the technology used by participants during the rather short study period. In comparison, the intercept term of the non-participant cost function shifted downwards during the 1978/79 to 1981/82 study period. Since no changes occurred in the factor demand slopes, the non-participants technology experienced changes of a neutral type. Thus, for non-participants technical efficiency increased. That is, the cost per unit of output forthcoming from the inputs used has diminished, or conversely, a higher output can be obtained from the same input bundle. This implies that, unlike participants, non-participants of PRODEMATA would be able to operate at larger margins in 1981/82 compared to 1978/79. Seemingly, the participant farmers did not achieve the technological improvements preconized by the PRODEMATA program.

The estimated price parameters of the cost functions represent the cost share of each input. For the estimated cost functions, the cost share of labor and chemical fertilizer was quite large compared to the share of mechanized services. This confirms that the production technology used in the Zona da Mata has been labor-using and land-saving and that PRODEMATA has not significantly changed the technology used by small farmers of the Zona da Mata. Input/land ratios computed for participants and non-participants of PRODEMATA are shown in Tables 4-8 to 4-10. Labor and fertilizer used per hectare decrease with farm size. An opposite relationship is observed with mechanized services. If the smaller farm units face a lower implicit price for labor and a higher implicit price for land, then the predominance of labor using techniques in the small farm units as opposed to capital intensive techniques in the larger farm units can be explained. On the whole, small farms use more labor and intermediate inputs per unit of land and more marginal land than the large farms.

The prospect of increasing farm employment in the Zona da Mata region was a central objective of PRODEMATA. The analysis of factor employment showed no positive effects of PRODEMATA on the demand for resources. The demand structure remained stable through time for participants and non-participants[4] alike providing no evidence of positive employment effects of PRODEMATA. However, these results do not preclude the possibility of long-run effects.

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[4] Except in the case of chemical fertilizer.

Table 4-8. Levels of labor used per hectare by class of participation and tenancy class, 1978/79 and 1981/82

Tenancy Class	1978/79 Participants	1978/79 Non-Participants	1978/79 All Farmers	1981/82 Participants	1981/82 Non-Participants	1981/82 All Farmers
	← -	- - - Man-day/Hectare	- →			
Sharecropppers	41.539 (6.084)[a]	45.559 (3.391)	45.194 (3.126)	36.506 (5.702)	45.139 (3.505)	44.573 (3.300)
Landowners:						
I. 0-10 Ha	39.129 (3.806)	40.404 (4.145)	40.039 (3.143)	30.579 (2.980)	32.002 (3.248)	31.585 (2.447)
II. 10-50 Ha	21.005 (1.138)	16.828 (1.219)	19.122 (0.843)	19.202 (1.124)	14.242 (0.930)	16.864 (0.995)
III. 50-100 Ha	13.391 (1.564)	8.736 (0.716)	11.296 (0.960)	12.469 (1.377)	7.984 (0.908)	10.506 (0.908)
IV. >100 Ha	7.365 (0.867)	5.761 (0.799)	6.480 (0.596)	7.751 (1.219)	5.910 (0.712)	6.830 (0.714)
Average	21.717 (1.114)	27.799 (1.651)	25.237 (1.073)	18.744 (0.939)	24.173 (1.457)	21.886 (0.939)

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[a] Numbers in parentheses are standard deviations of the mean.

Table 4-9. Levels of fertilizer used per hectare by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - -	Thousands of	Cruzeiros/Hectare	- - - - - - - - - - - - - →		
Sharecroppers	0.914 (0.451)[a]	0.272 (0.073)	0.330 (0.079)	0.416 (0.312)	0.519 (0.129)	0.512 (0.122)
Landowners:						
I, 0-10 Ha	0.677 (0.242)	0.925 (0.340)	0.854 (0.252)	0.999 (0.259)	0.517 (0.109)	0.658 (0.110)
II. 10-50 Ha	0.495 (0.073)	0.129 (0.025)	0.330 (0.043)	0.735 (0.097)	0.268 (0.052)	0.515 (0.059)
III, 50-100 Ha	0.291 (0.066)	0.121 (0.038)	0.214 (0.041)	0.433 (0.134)	0.156 (0.043)	0.312 (0.079)
IV. >100 Ha	0.092 (0.039)	0.152 (0.099)	0.125 (0.057)	0.243 (0.084)	0.168 (0.067)	0.205 (0.053)
Average	0.467 (0.057)	0.355 (0.086)	0.402 (0.055)	0.660 (0.071)	0.364 (0.044)	0.490 (0.040)

[a] Numbers in parentheses are standard deviations of the mean.

Table 4-10. Levels of mechanized services used per hectare by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - - -	Thousands of	Cruzeiros/Hectare	- - - - - - - - - - - - - - →		
Sharecroppers	0.328 (0.328)[a]	0.015 (0.015)	0.043 (0.032)	---	0.032 (0.025)	0.030 (0.024)
Landowners:						
I. 0-10 Ha	0.045 (0.022)	0.021 (0.009)	0.027 (0.009)	0.036 (0.021)	0.051 (0.022)	0.047 (0.016)
II. 10-50 Ha	0.064 (0.021)	0.018 (0.006)	0.044 (0.012)	0.070 (0.023)	0.047 (0.024)	0.059 (0.017)
III. 50-100 Ha	0.034 (0.012)	0.007 (0.004)	0.022 (0.007)	0.082 (0.023)	0.029 (0.015)	0.059 (0.015)
Iv. >100 Ha	0.017 (0.012)	0.047 (0.024)	0.034 (0.014)	0.133 (0.123)	0.029 (0.015)	0.082 (0.062)
Average	0.061 (0.016)	0.018 (0.005)	0.037 (0.007)	0.072 (0.017)	0.041 (0.011)	0.054 (0.010)

[a] Numbers in parentheses are standard deviations of the mean.

CHAPTER V
IMPACT OF PRODEMATA ON THE LEVEL AND DISTRIBUTION OF INCOME

The allocation of rural credit is frequently used as an instrument to induce the adoption of modern technologies. The desired or expected effect of this policy is higher incomes per farm and reduced inequities in income distribution. The purpose of this chapter is to evaluate the impact of PRODEMATA on farm income by comparing its level and distribution before and during the project for both participants and non-participants.

Impact on the Level of Income

Farm household income is the value of net farm production minus the contribution of sharecroppers. If PRODEMATA has had a large influence on farm income growth in the Zona da Mata region then a time series comparison of participants and non-participants should reflect the impact of the project. The expected increases in small farm productivity should promote increases in farm household incomes. The hypothesis that PRODEMATA significantly increased income levels may be formally tested using the average farm household income data presented in Table 5-1. Standard statistical methods were used to compare group means. Detailed information concerning the test procedures and statistical results are presented in Appendix D. The main empirical results are summarized in the next two sections.

Table 5-1. Average farm household income of PRODEMATA farmers by participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - -	- - - - - - Thousands	of Cruzeiros - - - - - -	- - - - - - - -	- - - - - -	- - - - →
Sharecroppers	18.84 (7.06)[a]	7.69 (2.70)	8.70 (2.55)	33.28 (5.71)	15.07 (2.84)	16.27 (2.74)
Landowners:						
I. 0-10 Ha	33.80 (9.37)	7.34 (3.09)	14.90 (3.68)	22.85 (4.85)	12.58 (2.27)	15.58 (2.19)
II. 10-50 Ha	78.29 (16.48)	36.55 (9.77)	59.47 (10.16)	64.66 (7.72)	33.96 (4.05)	50.18 (4.63)
III. 50-100 Ha	137.45 (28.18)	89.93 (30.47)	116.06 (20.75)	165.08 (36.86)	94.02 (25.97)	133.99 (23.88)
IV. >100 Ha	158.90 (50.22)	156.05 (52.56)	157.33 (36.07)	182.94 (28.55)	127.65 (33.32)	155.29 (22.14)
All Units	86.95 (11.77)	36.02 (6.33)	57.48 (6.28)	88.72 (9.64)	37.42 (4.46)	59.03 (4.96)

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[a] Numbers in parentheses are standard errors of the mean.

Cross-Sectional Differences

For both years participants of PRODEMATA had larger average farm incomes than non-participants. However, statistically significant income differences were not found in every tenancy class. The level of farm incomes were equal from a statistical viewpoint for farmers in the tenancy classes III and IV both in 1978/79 and 1981/82 as well as for sharecroppers in 1978/79.

These findings could suggest a positive relationship between farm income and participation in PRODEMATA. However, the extent, if any, to which income differences should be attributed to PRODEMATA is uncertain. Farm incomes may also be associated with the farming structure and personal characteristics of farmers. Thus, the farm income differences may well have been the consequence of large resource endowments or personal characteristics rather than of the PRODEMATA program.

In a recent study using discriminant analysis, Gomes (1984) demonstrated that the proportion of land in crops, fixed capital endowment, education, cooperative participation, and age are major factors distinguishing potential participants in PRODEMATA. With the exception of age, each of these variables was shown to increase the odds of a given farmer participating in the program. These findings suggest that participants were among the more progressive farmers of the Zona da Mata.[1] If this is true, it is not surprising that they had larger incomes than non-participants.

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[1] Pita (1982) asserts that some of the participants of PRODEMATA already had credit from other sources when the program began in 1976/77.

Time Series Differences

A fundamental expectation is that the income growth rate of participants should be significantly higher than for non-participants. If this is not true, the research hypothesis that PRODEMATA has benefitted participant farmers can not be accepted. An evaluation of the 1978/79 and 1981/82 farm income growth of both groups lends no statistical support to the proposition that participants of PRODEMATA are making more progress than non-participants. In fact, the average 1981/82 income level of neither participants nor non-participants was above the 1978/79 level in a statistically significant fashion. In other words, no real income growth occurred for either group, suggesting that PRODEMATA had little, if any, impact on farm income growth over this period.

Given the structure and objectives of PRODEMATA, it was expected that participant farm incomes would increase at a faster rate for the smaller tenancy classes than for the larger classes. As shown in Table 5-2, this expected pattern of income growth among participant farmers did not occur. The farm income of participants in the smaller tenancy classes decreased while there were large increases observed for sharecroppers and larger tenancy classes. Surprisingly, farm incomes for the non-participant sharecroppers and farm owners in tenancy class I increased faster than for the corresponding participant classes. However, the differences in farm incomes across from 1978/79 to 1981/82 were not statistically significant, except for the case of non-participant sharecroppers.

Table 5-2. 1978/79-1981/82 percentage change in farm household income of PRODEMATA farmers by participation and tenancy class

Tenancy Class	Participants	Non-Participants
Sharecroppers	+77.0	+96.0
Landowners:		
I. 0-10 Ha	-33.0	+71.0
II. 10-50 Ha	-17.4	-7.0
III. 50-100 Ha	+20.0	+4.5
IV. >100 Ha	+15.0	-18.2
Sample Average	+2.0	+4.0

Note: 1981/82 income figures were expressed in 1978/79 currency values.

Impact on the Distribution of Income

This section provides a comparative evaluation of the impact of PRODEMATA on the income distribution of participants and non-participants. The criterion used for this evaluation was farm household income.

Cross-Sectional Comparisons

The Lorenz curves shown in Figures 5-1 and 5-2 illustrate the pattern of farm household income distribution of participants and non-participants in 1978/79 and 1981/82. The participants' Lorenz curve lies closer to the equality line than the curve for non-participants. This means that there was a higher income concentration among non-participants than among participants. In other words, income inequalities were greater among non-participants than among participants.

The 1978/79 Gini coefficient figures for participants and non-participants were 0.667 and 0.781, respectively. The computed Gini coefficients for participants and non-participants in 1981/82 were 0.582 and 0.652, respectively. Unfortunately, Gini coefficients do not possess statistical properties that allow statistical testing. Hence, all that can be said is that participants had a more equal distribution in both years. No causation may be inferred.

A tentative statistical evaluation of the association between participation and income distribution is possible using a Chi-squared test. Table 5-3 contains the actual and expected frequency distributions of each group by income class. The expected distribution

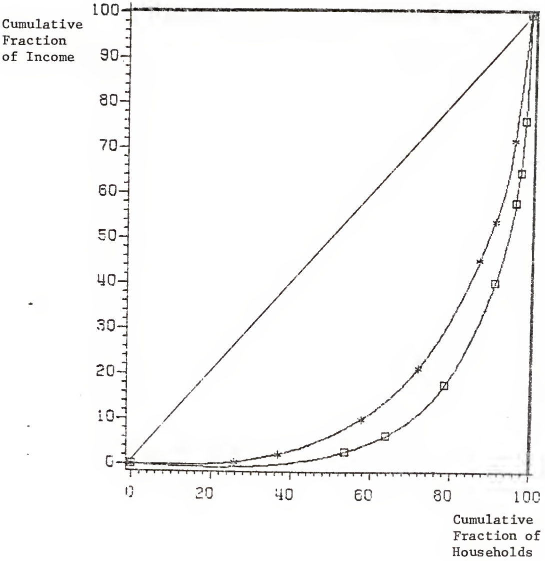

Figure 5-1. Lorenz curves for participants and non-participants of PRODEMATA using farm household income data of 1978/79

* = Participants
□ = Non-participants

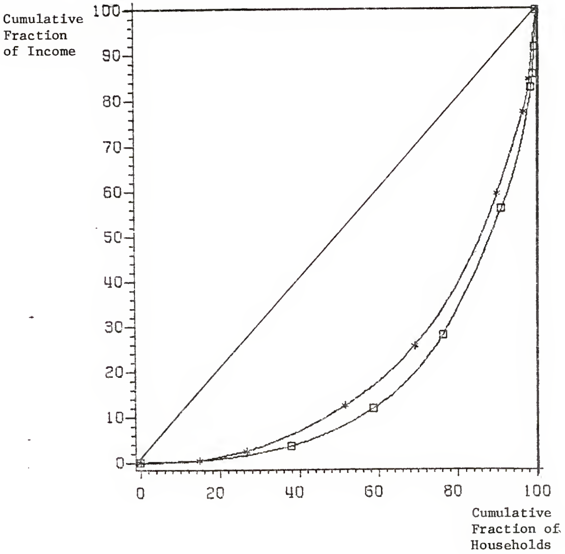

Figure 5-2. Lorenz curves for participants and non-participants of PRODEMATA using farm household income data of 1981/82

* = Participants
□ = Non-participants

Table 5-3. Two-way contingency table of farm household income level by class of participation and income class, 1978/79 and 1981/82

	1978/79			1981/82		
Income Class	Participant	Non-Participant	Total	Participant	Non-Participant	Total
0-10.0[a]	47 (76.26)	134 (104.75)	181	27 (51.40)	95 (70.60)	122
10.01-20.0	20 (19.38)	26 (26.62)	46	22 (31.18)	52 (42.82)	74
20.01-50.0	38 (31.60)	37 (43.40)	75	45 (37.49)	44 (51.50)	89
50.01-100.0	26 (24.01)	31 (32.99)	57	32 (29.07)	37 (39.93)	69
100.01-200.0	28 (17.27)	13 (23.73)	41	38 (24.01)	19 (32.99)	57
>200.1	23 (13.48)	9 (18.52)	32	18 (8.85)	3 (12.15)	21
Total	182	250	432	182	250	432

[a] Measured in Cr$1,000.

(in parentheses) are what would be observed if the hypothesis of independence were true. The test statistic is given by

$$\chi^2 = \Sigma \frac{[n_{ij} - \hat{E}(n_{ij})]^2}{\hat{E}(n_{ij})}$$

where

$\hat{E}(n_{ij}) = \frac{r_i \, c_j}{n}$ = estimated cell frequencies assuming a random distribution;

n_{ij} = observed cell frequencies;

r_i = total count for row i;

c_j = total count for column j; and

n = total observed counts.

This test statistic has a Chi-squared distribution with (r - 1) (c - 1) degrees of freedom. Large values of χ^2 imply that the observed and expected counts do not closely agree; therefore, the hypothesis of independence is rejected.

The computed χ^2 values were large enough to reject the hypothesis of independence between PRODEMATA participation and the distribution of income in both 1978/79 and 1981/82.[2] The results of this test suggest that an association between PRODEMATA participation and the observed distributions exists. Unfortunately, only association, not causation can be tested. These income distribution patterns may be the consequence of resource distribution, which is more equitable among participants than non-participants.[3,4]

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[2] The computed χ^2 values for 1978/79 and 1981/82 were, respectively, 41.79 and 49.12. The χ^2 tabled values at 0.01 probability level with 5 degrees of freedom is 15.08.

Time Series Comparisons

According to the computed Gini coefficients, income concentration in 1981/82 was lower than in 1978/79. While the Gini coefficients for participants was 12.7 percent lower, that for non-participants was 16.5 percent lower. These results are striking in the sense that more redistribution has occurred among non-participants, even though an explicit objective of PRODEMATA was to improve the distribution among participants

As shown in Table 5-4, the gains in income for both groups occurred in the middle 40 percent and bottom 40 percent of the income recipients. The redistribution is notably higher in the non-participant sample.

The hypothesis that the participant and non-participant income distribution patterns changed over time can be tested with a Chi-square test of the two-way contingency tables in Table 5-5. The hypothesis of independence is rejected for non-participants but for participants of PRODEMATA it can not be rejected.[5] This implies that no

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[3] The distributional measures for resources can be found in Appendix E.

[4] The Gini coefficients of the credit distribution for participants and non-participants in 1978/79 were 0.68 and 0.93, respectively. In 1981/82 the Gini coefficients for participants and non-participants were 0.66 and 0.89, respectively, suggesting a slight decrease in concentration of credit for both groups.

[5] The computed χ^2 values for participants and non-participants were, respectively, 8.79 and 23.86. The χ^2 table value at 0.01 probability level with 5 degrees of freedom is 15.08.

Table 5-4. Changes in farm households income shares of PRODEMATA farmers by class of participation, 1978/79-1981/82

Class	Bottom 40%	Middle 40%	Top 20%
Participants	+0.29	+8.07	-8.36
Non-Participants	+1.53	+12.15	-13.68

Table 5-5. Two-way contingency table of farm household income level by class of participation and income class, 1978/79-1981/82

	Participants			Non-Participants		
Income Class	1978/79	1981/82	Total	1978/79	1981/82	Total
0-10.0[a]	47 (37.0)	27(37.0)	74	134 (114.5)	95 (114.5)	229
10.01-20.0	20 (21.0)	22 (21.0)	42	26 (39.0)	52 (39.0)	78
20.01-50.0	38 (41.5)	45 (41.5)	83	37 (40.5)	44 (40.5)	81
50.01-100.0	26 (29.0)	32 (29.0)	58	31 (34.0)	37 (34.0)	68
100.01-200.0	28 (33.0)	38 (33.0)	66	13 (16.0)	19 (16.0)	32
>200.01	23 (20.5)	18 (20.5)	41	9 (6.0)	3 (6.0)	12
Total	182	182	364	250	250	500

[a] Measured in Cr$1,000.

statistically significant changes occurred in the income distribution over the 1978/79 to 1981/82 period even though such a change did occur for non-participants. Therefore, it can be concluded that in the period analyzed PRODEMATA policy did not affect farm income distribution in a significant fashion.

Summary

The statistical analysis of cross-sectional PRODEMATA data show that participants had higher income levels than non-participants. For sharecroppers in 1981/82, and for owners of the smaller tenancy classes in both years the income differences were statistically significant. It is not known whether the cross-sectional differences in farm incomes were due to the impact of PRODEMATA credit or whether the differences were a simple result of previous differences in resource endowment and/or the socioeconomic characteristics of the sample farmers.

If PRODEMATA has been successful then the participant income growth rate should have been greater than that of non-participants. However, an evaluation of the changes over the 1978/79 to 1981/82 period suggest that PRODEMATA had little, if any, differential impact on farm income growth during the period.

As indicated by the Lorenz curves and Gini coefficients, the distribution of farm income was more equitable among participants than among non-participants in both 1978/79 and 1981/82. A test of the cross-sectional data of participants and non-participants led to the conclusion that the income distributions of participants and non-participants were statistically different. However, nothing can be said concerning the impact of rural credit itself on the income distribution.

While the Gini coefficients were lower for participants than for non-participants, the findings based on time series comparisons offered no statistical evidence that significant inprovements occurred in the distribution of income among participants of PRODEMATA. Therefore, it is concluded that, during 1978/79 to 1981/82, PRODEMATA programs had no discernable effect on the income distribution of farmers in the Zona da Mata.

CHAPTER VI
SUMMARY AND CONCLUSIONS

The purpose of this chapter is to present an overview of the problem studied, the methodology and procedures used, and the results obtained from the analyses. In the first section a brief review of the problem and research objectives is presented. The second section is dedicated to a review of the research methodology and of the empirical findings. The third section focuses on the conclusions and implications. Finally, the limitations of the research and suggestions for further studies are developed.

The Problem and the Research Objectives

The Brazilian agricultural sector has experienced outstanding economic growth in recent years. Despite this, the agricultural sector in many areas continued to be predominately subsistence oriented. Even in the rapidly growing Southeast, rural poverty problems are common in many regions of Sao Paulo and Minas Gerais States. For this reason, increased attention has focused on developing economic policies to address the unique difficulties of the rural poor.

This research examines the impact of a rural development program aimed at the improvement of small farmers through the use of subsidized credit. The geographic setting is the Zona da Mata region, located in the Southeastern Minas Gerais State. The Zona da Mata was a leading region of the state economy during the coffee era. However, the lack of adequate management and proper agricultural policies eventually degraded the soils leading to increasingly lower yields and declining revenues. The coffee eradication program conducted in the 1962 to 1966 period contributed further to the economic depression of the area since labor-intensive coffee was replaced with labor-extensive dairy as the dominant agricultural activity. Today, the economic status of the rural population in the Zona da Mata is markedly poor and the prospects for improvement are bleak.

Since 1976, financial resources have been brought to the area through the implementation of the Integrated Rural Development Program of the Zona da Mata (PRODEMATA). This program is sponsored by the World Bank in a joint effort with several state agencies. The overall objective is to improve the quality of life and increase farm income in the region. To attain this latter objective, a comprehensive supervised credit project was designed to deliver financial resources together with technical assistance to small farmers. The expectation was that these incentives would induce the adoption of more productive labor-using technologies by participating farmers.

The supervised credit component of PRODEMATA was the subject of this research. The objective of the study was to evaluate the impact of the PRODEMATA program on factor employment (especially the demand for labor), farm income growth, and income distribution.

Research Methodology and Summary of the Findings

Data and Methodology

The data used in this research were collected by the Department of Agricultural Economics of the Federal University of Vicosa (UFV) in each crop year since 1976/77. This study was limited to the 1978/79 and the 1981/82 data. The samples used included 182 farmers who participated in PRODEMATA in at least one year since its inauguration, and 250 farmers who never participated. The information provided by the farm level questionnaires was assembled into two similar data sets: family unit and farm management unit. The family-unit data contained all revenues and costs of the farm household as declared by the interviewee. The farm management data contained essentially the same information but the input costs and labor used were increased to include the contributions of sharecroppers to the unit under managerial control of the interviewee.

The farm management data set was used to evaluate the impact of PRODEMATA on the demand for resources. This evaluation was accomplished by comparing a system of demand equations derived from Cobb-Douglas cost functions estimated with cross-sectional and time series data of participants and non-participants of PRODEMATA. Standard statistical analysis was used to test hypotheses concerning the induced changes in the demand for factor services.

The family-unit data were used to analyze changes in the income level and distribution associated with PRODEMATA. Standard statistical tests, Lorenz curves, and Gini coefficients were used to compare differences in farm household income levels and distribution between participants and non-participants of PRODEMATA.

Summary of the Findings

The statistical results of this study suggest that PRODEMATA had no significant impact on the demand for inputs. The cross-sectional comparisons indicated that no statistically significant differences existed between participant and non-participant demand functions.[1] Moreover, PRODEMATA produced no statistically significant demand shifts between 1978/79 and 1981/82 even though such shifts were expected to result from the PRODEMATA program. Based on the cost function comparisons it was shown that, unlike participants, non-participants of PRODEMATA improved their technical efficiency during the 1978/79 to 1981/82 period.

The empirical results also suggest that PRODEMATA did not induce changes in the character of the technology used by the farmers. The cost shares were shown to be statistically equal between participants and non-participants and stable when the time series estimates were compared. For both comparison groups the technology was markedly intensive in labor and fertilizer and extensive in mechanized services.

An evaluation of the farm household income data indicated that the average income of PRODEMATA participants was higher than for non-participants in both years. The income differences between participants and non-participants were shown to be statistically different for farm owners in the two smaller tenancy classes in each year and for sharecroppers in 1981/82. However, those income differences could be a simple result of previous differences in resource endowments and/or personal characteristics of farmers, rather than an effect of PRODEMATA. A statistical evaluation of the changes from 1978/79 through 1981/82 provided no evidence of a significant impact of PRODEMATA on farm income growth over the period analyzed.

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[1] Except in the case of chemical fertilizer in 1981/82. However, no economic significance is attached to this statistical result.

The distribution of farm income, as measured by the Gini coefficients, was more equitable for participants than for non-participants in both 1978/79 and 1981/82. The computed Gini coefficients for participants and non-participants were, respectively, 0.667 and 0.781 in 1978/79 and 0.582 and 0.652 in 1981/82. A Chi-squared test applied on the cross-sectional data supported the evidence that the income distributions in each year, for each comparison group, were statistically different. However, on the basis of the test, nothing can be said concerning the impact of rural credit itself on the income distribution since it did not imply direct causation. Even though the Gini coefficients were lower in 1981/82 than in 1978/79 for both comparison groups, the findings based on time series comparisons (a Chi-squared test), offered no statistical evidence that significant improvements occurred in the distribution of income among participants of PRODEMATA. Therefore, it was concluded that during the period 1978/79 through 1981/82, the program had no discernable effect on the income distribution of farmers in the Zona da Mata.

Conclusions and Implications

In addition to the anticipated positive impact on income growth it was hypothesized that PRODEMATA would have salubrious effects on the distribution of income and the demand for resources. Unfortunately, the results of this research led to the conclusion that PRODEMATA produced no significant changes in the production structure of participant farmers in the Zona da Mata during the study period. Consequently, no significant changes were observed in the demand for labor and other productive inputs. The findings of this research also led to the conclusion that the effect of the program on farm income growth was negligible and that the pattern of the income distribution was not significantly altered by PRODEMATA during the study period.

If it is assumed that the procedures adopted in this research were adequate, then the immediate implication is that the policy of extending credit to small farmers of the Zona da Mata was ineffective. The explanation for the poor performance of the program may reside in difficulties in implementing the PRODEMATA scheme, reluctance of farmers to participate, etc. The objective of the next section is to draw some policy implications for the region based on the results of the research and to suggest some possible causes of the apparent failure.

Implications for the Region

Economic policies specifically designed to strengthen both on-farm and off-farm employment opportunities are needed in the Zona da Mata. As suggested by the results of this research, PRODEMATA failed to generate increased employment. As an alternative to credit policies, planners should consider policies designed to change existing crop mixes and/or introduce new, labor intensive crops in the area, particularly on large farms. The introduction of rural public works such as those adopted in Thailand should also be considered (Krongkaew, 1982). Finally, efforts to diffuse improved agronomic practices such as double-cropping and other labor-using techniques should be strengthened.

The distribution of income did not change significantly during the course of PRODEMATA. Obviously, this result corroborates the observed lack of improvement in the incomes of the smaller farm units. Improving the level of farm income of small producers in the Zona da Mata continues to be a challenge for policy makers. Many contend that a more even distribution of income constitutes an important prerequisite for future improvements in the demand for goods and social well being in the region. The evidence of high income concentration and the lack of improvement in it demonstrates the difficulty of stimulating structural changes. The implementation of government programs and policies aimed at the improvement of labor productivity and raising the income of disadvantaged groups is one of the means for bringing about such changes.

Causes of Failure and Implications

The apparent failure of the credit project may have been caused by rural credit not being used in a manner consistent with the objectives of PRODEMATA. There are ample bureaucratic obstacles to the effective implementation of credit policies in the region and prior experience in this field is limited (World Bank, 1976). One way to cope with these programmatic difficulties is through more effective evaluation and follow-up services. Periodic information concerning the evolution of the program would provide a basis for policy intervention.

The attitudes of small farmers toward risk may have influenced farmers' decisions concerning use of credit. If new technologies are perceived as having a high risk level, they may be unacceptable to small farmers irrespective of the availability of credit. If this is the case, then credit alone is not sufficient to induce the structural changes needed in the region. The agricultural research and extension services could make a significant contribution to the solution of this problem by developing and diffusing new, low-risk production technologies suitable for small farms. Agricultural policies aimed at the reduction of production and market risk such as crop insurance and support prices are needed to overcome small farmers risk aversion.

Another reason PRODEMATA appears to have failed may have been due to discontinuities in the assistance to program participants. For example, legal restrictions imposed on rural credit and higher interest rates inaugurated in 1980/81 (Pita, 1982) may have influenced farmers credit use during the study period. There is evidence that financial resources became scarce by the end of the first phase of PRODEMATA in 1981/82. These factors led to discontinuities in program participation such that only 55 percent of the participant farmers who received credit in 1978/79 borrowed in 1981/82.

Finally, it is possible that PRODEMATA was in fact effective but the positive results were not detected by this research. If this is the case, then a less restrictive methodology than that which was adopted in this study could lead to different conclusions. For example, the adoption of improved technology and increases in the area under cultivation were expected to increase both farm productivity and production. It is possible that these changes were not realized during the relatively short time period considered in this study.

In specifying the model, several sets of regressors and/or functional forms were fitted to the PRODEMATA data. The same sample information was used to estimate alternative models and to test hypotheses. The process used leads to pretest estimators. In such cases, the OLS estimates and traditional tests do not attain their desirable properties in repeated samples.[2] Other methodological shortcomings may include an inappropriate sample, a restrictive functional form for estimating the cost functions, and common statistical errors.

Limitations and Suggestions for Further Research

This study attempted to evaluate the impact of supervised credit on small farms in the Zona da Mata. Obviously, this study was not without limitations. The necessity of further research to increase understanding of the role of credit in the development process is fully recognized.

The absence of any significant impact of PRODEMATA may have been a consequence of participants' attitudes toward risk. Thus, the inclusion of an explicit risk component in further analyses of PRODEMATA would enhance the evaluation of credit projects. In addition, efforts should be made to determine whether the credit received was used in a manner consistent with the objectives of PRODEMATA.
A study of the factors that affect credit use in the Zona da Mata would also be valuable for future programs. This is important because of the

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[2] For discussion of pretest estimator see, for example, Judge (1980) and Kennedy (1980).

limited experience in small farm credit programs and the well known institutional barriers to implementation of supervised credit programs in the region.

The mix of agricultural enterprises is not uniform throughout the Zona da Mata region. Therefore, the impact of PRODEMATA may have been different in different regions. Recognizing these regional differences in future research should enhance the identification of cause and effect in credit programs. Another extension of this study might emphasize an analysis of the different crop mixes in the region, particularly those which have been targeted by PRODEMATA. There is a need for more information on how changes in crop mixes would affect the regional economy as a whole.

This study sought to evaluate the impact of PRODEMATA on the production structure from a short-run prospective. In the long run, income growth is positively influenced by capital accumulation. A sizeable portion of PRODEMATA credit was dedicated to finance on-farm investment. Therefore, an important topic for further analysis is the effect of PRODEMATA on capital accumulation. Perhaps of utmost importance is an evaluation of the long-run costs and benefits of the program in the study region.

The analytical framework followed in this research was not able to determine if the cross-sectional differences between participants of PRODEMATA and non-participants were caused by differences which existed before the inauguration of PRODEMATA or whether those differences were associated inextricably with participation in the credit program. Further analyses of PRODEMATA should attempt to shed light on this issue.

This study used cost functions to analyze the production process of participant and non-participant farmers. The main advantage of this approach is that the factor demand functions can be obtained directly from the cost function by simple differentiation. Severe multicollinearity problems occured when using the translog or the Leontief specifications. For this reason, a Cobb-Douglas cost function was adopted. However, the Cobb-Douglas cost function used in this study presents several severe limitations. Further studies using different sets of data for the Zona da Mata should attempt to use more flexible functional forms such as the translog or Leontief functions. Unlike the Cobb-Douglas, they allow a more complete analysis of factor substitution in the production process.

One advantage of using cost functions rather than production functions in estimating the production parameters is that cost functions have factor prices rather than factor use as independent variables. Unfortunately, the availability of data on factor prices was limited to labor, fertilizer, mechanized services, and draft animal services. Since no theoretical reason exists for eliminating all other inputs, specification errors may have occurred. Future data collection should emphasize a more explicit solicitation of price information from the interviewees.

APPENDICES

APPENDIX A
VARIABLE DEFINITIONS

The variables used in this research were divided into two data sets called the family unit and the farmer management unit. Variables in the family unit data set were taken directly from the questionnaires and refer to the revenues and expenses of the interviewee only. As explained in Chapter II, the data on input costs and labor used in the farm management unit were corrected to take into account the sharecropper contributions. Therefore, the definition of a variable will be different depending on whether it is included in the family unit or in the farm management unit data set.

The variables used in this study were defined as follows:

(a) Gross Value of Production (GVP) is the sales value of all farm production derived from crop and livestock activities. It includes the market value of crop and/or livestock products consumed on the farm. Since on-farm consumption data includes both human and animal consumption, some double counting may occur in computing the income from livestock sales. However, given the typical production patterns of the area, any double counting is felt to be of little material significance. GVP is measured in Cr$1,000 and was used in the farm management unit data as a measure of the farm output. GVP was also used for computation of the farm household income in the family unit data set. In this case, production of sharecroppers was not included in the GVP.

(b) Fixed capital (FC) is defined as the stock value of buildings, machinery and farm equipment plus the value of productive and draft livestock owned by the interviewee. Fixed capital is measured as a stock rather than variable. The valuation was provided by the interviewee in the farm level questionnaires and it is measured in Cr$1,000.

(c) Operating capital (OPC) is the value of the production inputs (chemical and organic fertilizer, seeds, pesticides, herbicides, feed, vaccines and medicines) plus mechanized and draft animal services used, whether owned or purchased. Fertilizer (chemical and organic), mechanized services and draft animal services were evaluated at the prices given by the interviewees. In the cost of seeds, pesticides, herbicides, feed, vaccines and medicines only expenditures were reported in the questionnaires. Therefore, no unit price information could be derived. The operating capital for the farm management unit includes inputs provided by sharecroppers.[1]

(d) Total labor cost measures the value of all labor used on the farm evaluated at the average wage rate reported by each farmer. The quantity of labor used is measured in man-day equivalents. The labor provided by women and children was transformed into man-day equivalents using a conversion factor of 0.75 and 0.50, respectively. The labor used by the farm management unit includes sharecropper labor. The labor used by the family unit is limited to family labor and hired labor. The total labor cost was measured in Cr$1,000.

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[1] The procedure for estimating the sharecropper contributions can be found in Chapter II. The farm management unit data set was used for the estimations of the Cobb-Douglas cost function in Chapter IV.

(e) Total variable cost is defined as the sum of operating capital (OPC) and total labor cost.

(f) Share of factor cost is the ratio of the total expenditures on a variable input to the total variable cost.

(g) Off-farm income is the reported income generated from off-farm jobs. It is obtained by multiplying the number of man-days worked off the farm times the wage rate received. Off-farm income is divided into (1) off-farm income from non-agricultural activities and (2) off-farm income from agricultural activities.

(h) Farm household income is the gross value of production less the contribution given to sharecroppers minus the family expenses for operating capital and labor. Farm household income is measured in Cr$1,000.

APPENDIX B
ESTIMATED COEFFICIENTS USED IN THE SHARECROPPED AREAS

Table B-1. Regression equations used to estimate the amount of labor used in sharecropped areas, 1978/79

Crops	Constant Term	Cultivated Area	$\overline{R}^2$
Beans	2.9559 (38.31)[a]	-0.4335 (4.51)	21.19
Coffee	3.5714 (38.31)	-0.1530 (2.48)	3.02
Corn	3.4629 (72.37)	-0.4153 (9.51)	26.60
Corn-beans	2.7409 (36.96)	-0.5775 (7.19)	23.08
Rice	3.6849 (64.95)	-0.5639 (8.75)	31.67
Sugarcane	3.1645 (32.40)	0.3549 (4.61)	23.50
Tobacco	4.4224 (15.75)	0.0705 (0.23)	-0.09

[a] Numbers in parentheses are t-values.

Table B-2. Regression equations used to estimate the amount of labor used in sharecropped areas, 1981/82

Crops	Constant Term	Cultivated Area	$\bar{R}^2$
Beans	3.2514 (31.97)[a]	-0.3628 (2.98)	25.60
Corn	3.3707 (23.13)	-0.2109 (1.40)	2.06
Corn-beans	2.5812) (11.51)	-0.8305 (2.94)	35.60
Rice	3.8256 (32.66)	-0.4478 (3.89)	26.60

[a] Numbers in parentheses are t-values.

APPENDIX C
TESTS OF THE EQUALITY AND STABILITY OF DERIVED DEMAND PARAMETERS

This appendix contains all the estimates used for the statistical tests in Chapter IV. For testing the demand parameters restricted estimates of the cost functions were obtained in a manner such that the derived demand functions contain either a common intercept or a common slope for participants and non-participants.[1] For example, assume that the intercept of the demand for labor (X_L) is equal for participants and non-participants while the other parameters differ.

Then the cost function, using pooled dates of non-participants and participants, is estimated as:

$$\begin{aligned} \ell n\ (C/P_D) \; = \; & \ell n\ K + \alpha_y\ \ell n\ Y + \alpha_y'\ \ell n\ Y + \alpha_L\ \ell n\ (P_L/P_D) \\ & + \alpha_F\ \ell n\ (P_F/P_D) + \alpha_F'\ \ell n\ (P_F'/P_D) + \alpha_M\ \ell n\ (P_M/P_D) \\ & + \alpha_M'\ \ell n\ (P_M'/P_D) \qquad (1) \end{aligned}$$

such that the restriction is incorporated on the derived demand equation.

$$C \; = \; K\ Y^{\alpha_y}\ Y^{\alpha_y'}\ P_F^{\alpha_F}\ P_L^{\alpha_L}\ P_F^{\alpha_F'}\ P_M^{\alpha_M}\ P_M^{\alpha_M'}\ P_D^{\alpha_D} \qquad (2)$$

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[1] Restricted estimates were also used in the sense that for each group of farmers, either the intercept or the slope of the derived demand function of 1978/79 and 1981/82 are equal.

and the demand for labor is given by

$$\frac{\partial C}{\partial P_L} = X_L = \alpha_L K Y^{\alpha_y} Y^{\alpha_y'} P_L^{\alpha_L - 1} P_F^{\alpha_F} P_F^{\alpha_F'} P_M^{\alpha_M} P_M^{\alpha_M'} P_D^{\alpha_D} \qquad (3)$$

where

$\alpha_L K$ = intercept of the demand for labor.

Therefore, if the intercept of the cost function and the price coefficient of labor in the cost equation are restricted to be equal, the intercept of the demand equation will also be equal. A general formulation, similar to the example shown in (1) was adopted to estimate the cost function using pooled data of participants and non-participants. Similar modifications were introduced in the cost functions in order to impose restrictions on the price coefficients only.

The unrestricted estimates are the cost functions estimated separately for non-participants and participants.[2] In this case the demand functions of non-participants and participants would have different intercepts and slopes, since all the coefficients are allowed to vary. The estimates used for testing the equality and stability of the cost functions are shown in Tables C-1 through C-4. The estimates used for testing the equality and stability of the derived demand functions are reported in Tables C-5 through C-14.

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[2] Restricted estimates of the cost functions consists of those estimates obtained using pooled data of participants and non-participants or pooled data of both years for each group, assuming that all the cost parameters are equal.

Table C-1. Estimates used for testing the equality of the cost function parameters, 1978/79

Cost Function	Parameters	1978/79 Estimates		
		Pooled	Participants	Non-participants
Constant	$\ell n\ K$	-3.077992** (0.256516)[a]	-2.572867** (0.305879)	-3.211195* (0.404832)
Fertilizer	α_F	0.212144** (0.079783)	0.218288* (0.085986)	0.195912 (0.130767)
Labor	α_L	0.534265** (0.088522)	0.561674** (0.105409)	0.547465** (0.130767)
Mechanized Services	α_M	0.106990* (0.043275)	0.104378* (0.044775)	0.085598** (0.074776)
Output	α_Y	0.650659** (0.023177)	0.566601** (0.034078)	0.654679** (0.035447)
R^2	---	71.06	74.75	63.78
N	---	430	181	249
SSE	---	143.292748	35.130592	105.365394

[a] Numbers in parentheses are standard deviations.

*Significant at 0.05-0.10 probability level.

**Significant at 0.01 probability level.

Table C-2. Estimates used for testing the equality of the cost function parameters, 1981/82

Cost Function	Parameters	1981/82 Estimates		
		Pooled	Participants	Non-participants
Intercept	ℓn K	-3.698671** (0.224176)[a]	-3.110738** (0.343583)	-3.838919** (0.313819)
Fertilizer	α_F	0.239149** (0.085062)	0.248141** (0.130643)	0.208690 (0.116254)
Labor	α_L	0.666195** (0.085689)	0.615846** (0.137601)	0.710698** (0.109776)
Mechanized Services	α_M	0.086865 (0.048012)	0.110344 (0.061999)	0.084770 (0.073262)
Output	α_Y	0.796004** (0.024700)	0.690152 (0.045838)	0.799414** (0.033545)
R^2	---	77.99	63,61	75.00
N	---	428	182	246
SSE	---	135,692568	51.071607	80.647971

[a] Numbers in parentheses are standard deviations.

*Significant at 0.05-0.10 probability level.

**Significant at 0.01 probability level.

Table C-3. Estimates used for testing the stability of the cost function in parameters, 1978/79-1981/82, participants

Cost Function	Parameters	Participants Estimates		
		Pooled (1978/79-1981/82)	1978/79	1981/82
Constant	$\ln K$	-2.976939** (0.212496)[a]	-2.572867** (0.305879)	-3.110738** (0.343583)
Fertilizer	α_F	0.170287** (0.065681)	0.218288* (0.085986)	0.248141** (0.130643)
Labor	α_L	0.661770* (0.072258)	0.561674** (0.105409)	0.615846** (0.137601)
Mechanized Services	α_M	0.103608** (0.035506)	0.104378* (0.044775)	0.110344 (0.061999)
Output	α_Y	0.622518 (0.027686)	0.566601** (0.034078)	0.690152 (0.045838)
R^2	---	74.67	74.75	63.61
N	---	363	181	182
SSE	---	88.130312	35.130592	51.071607

[a] Numbers in parentheses are standard deviations.

*Significant at 0.05-0.10 probability level.

**Significant at 0.01 probability level.

Table C-4. Estimates used for testing the stability of the cost function parameters, 1978/79-1981/82, non-participants

		Non-participant Estimates		
Cost Function	Parameters	Pooled (1978/79-1981/82)	1978/79	1981/82
Constant	$\ell n\ K$	-3.895184** (0.229601)[a]	-3.211195** (0.404832)	-3.838919** (0.313819)
Fertilizer	α_F	0.063468 (0.078786)	0.195912 (0.130767)	0.208690 (0.109776)
Labor	α_L	0.765627 (0.073639)	0.547465** (0.130767)	0.710698** (0.109776)
Mechanized Services	α_M	0.051922 (0.050479)	0.085598** (0.074776)	0.084777 (0.073262)
Output	α_Y	0.719821** (0.024751)	0.654679** (0.035447)	0.799414** (0.033545)
R^2	---	68.64	63.76	75.00
N	---	495	249	246
SSE	---	194.383832	105.365394	80.647971

[a] Numbers in parentheses are standard deviations.

*Significant at 0.05-0.10 probability level.

**Significant at 0.01 probability level.

Table C-5. Restricted estimates used for testing the equality of the intercept and slope, demand for labor, 1978/79

Cost Function[a]	Parameters	Pooled Estimates Constant Intercept	Pooled Estimates Constant Slope
Constant term	ℓn K	-2.941124** (0.264561)[b]	-2.559795** (0.359225)
	ℓn K'	---	-3.223530** (0.319798)
Fertilizer	α_F	0.160802* (0.084071)	0.223115* (0.092881)
	$\alpha_{F'}$	0.268277** (0.089000)	0.191639* (0.101443)
Labor	α_L	0.540780* (0.088731)	0.553517** (0.088952)
	$\alpha_{L'}$	---	---

Table C-5—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.124743** (0.053672)	0.105824* (0.054925)
	$\alpha_{M'}$	0.065537 (0.062974)	0.084416 (0.064011)
Output	α_Y	0.601279** (0.038162)	0.566604** (0.044064)
	$\alpha_{Y'}$	0.645141** (0.030614)	0.654636** (0.031157)
R^2	---	71.46	90.38
Sample Size	---	430	430
SSE	---	141.316542	140.498068

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-1.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-6. Restricted estimates used for testing the equality of the intercept and slope, demand for labor, 1981/82

		Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-3.519051** (0.229745)[b]	-3.209094** (0.307124)
	$\ell n\ K'$	---	-3.794352** (0.292439)
Fertilizer	α_F	0.142588 (0.96813)	0.201403* (0.104142)
	$\alpha_{F'}$	0.311252** (0.091360)	0.228740* (0.106190)
Labor	α_L	0.685149 (0.085491)	0.677089** (0.085524)
	$\alpha_{L'}$	---	---

Table C-6—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.126122* (0.061594)	0.103211 (0.063324)
	$\alpha_{M'}$	0.050828 (0.064982)	0.090969 (0.070065)
Output	α_Y	0.715788** (0.044227)	0.688285** (0.047732)
	$\alpha_{Y'}$	0.792148** (0.032256)	0.798834** (0.032506)
R^2	---	78.50	92.38
Sample Size	---	428	428
SSE	---	132.532761	131.808104

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-7. Restricted estimates used for testing the equality of the intercept and slope, demand for fertilizer, 1978/79

		Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-3.043075** (0.258481)[b]	-2.604816** (0.322933)
	$\ell n\ K'$	---	-3.177828** (0.264162)
Fertilizer	α_F	0.203641** (0.080284)	0.207473** (0.079220)
	$\alpha_{F'}$	---	---
Labor	α_L	0.550872** (0.117904)	0.571291** (0.117695)
	$\alpha_{L'}$	0.541732** (0.100874)	0.538951** (0.100402)

Table C-7—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.097118* (0.058081)	0.104395* (0.057896)
	$\alpha_{M'}$	0.104420 (0.065242)	0.084842 (0.065515)
Output	α_Y	0.648490** (0.024854)	0.566620** (0.044064)
	$\alpha_{Y'}$	0.623875** (0.027927)	0.655023** (0.031065)
R^2	---	71.29	90.38
Sample Size	---	430	430
SSE	---	142.184657	140.502518

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-1.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-8. Restricted estimates used for testing the equality of the intercept and slope, demand for fertilizer, 1981/82

		Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slopes
Constant term	$\ell n\ K$	-3.573907** (0.232555)[b]	-3.159471** (0.284388)
	$\ell n\ K'$	---	-3.799678** (0.248121)
Fertilizer	α_F	0.252180* (0.086706)	0.224697** (0.086866)
	$\alpha_{F'}$	---	---
Labor	α_L	0.616385** (0.113175)	0.635693** (0.112739)
	$\alpha_{L'}$	0.702656** (0.099939)	0.702184** (0.099320)

Table C-8—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.092189 (0.063652)	0.112778* (0.068807)
	$\alpha_{M'}$	0.079701 (0.069235)	0.080853 (0.068807)
Output	α_Y	0.785427** (0.026033)	0.687922* (0.046792)
	$\alpha_{Y'}$	0.766310** (0.029490)	0.800252** (0.032297)
R^2	---	78.31	92.39
Sample Size	---	428	428
SSE	---	133.701559	131.735214

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-9. Restricted estimates used for testing the equality of the intercept and slope, demand for mechanized services, 1978/79

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-2.926769** (0.264639)[b]	-2.574746** (0.395432)
	$\ell n\ K'$	---	-3.211923** (0.355890)
Fertilizer	α_F	0.136125 (0.087509)	0.218337 (0.111187)
	$\alpha_{F'}$	0.279774** (0.089292)	0.193797* (0.114539)
Labor	α_L	0.636291** (0.118705)	0.569733** (0.131016)
	$\alpha_{L'}$	0.636291** (0.118705)	0.540878** (0.113315)

Table C-9—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.094908** (0.043459)	0.096174* (0.043449)
	$\alpha_{M'}$	---	---
Output	α_Y	0.587754** (0.040414)	0.566665** (0.044065)
	$\alpha_{Y'}$	0.649126** (0.030843)	0.654504** (0.031152)
R^2	---	71.53	90.38
Sample Size	---	430	430
SSE	---	140.989991	140.511324

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-1.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-10. Restricted estimates used for testing the equality of the intercept and slope, demand for mechanized services, 1981/82

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-3.554395** (0.229972)[b]	-3.104652** (0.357931)
	$\ell n\ K'$	---	-3.858439** (0.295218)
Fertilizer	α_F	0.122847 (0.108980)	0.253489* (0.134888)
	$\alpha_{F'}$	0.299750** (0.089330)	0.200083* (0.107948)
Labor	α_L	0.748924** (0.118752)	0.622503** (0.141445)
	$\alpha_{L'}$	0.644068** (0.097506)	0.704912** (0.104164)

Table C-10—Continued

Cost Function[a]	Parameters	Pooled Estimates Constant Intercept	 Constant Slope
Mechanized Services	α_M	0.091638* (0.047733)	0.098741* (0.047835)
	$\alpha_{M'}$	---	---
Output	α_Y	0.717103** (0.044627)	0.692550** (0.046995)
	$\alpha_{Y'}$	0.789212 (0.031716)	0.798051** (0.032110)
R^2	---	78.49	92.37
Sample Size	---	428	428
SSE	---	132.584892	131.74855

[a] The unrestricted estimates are the participant and non-participant estimates presented in Table C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-11. Restricted estimates used for testing the stability of the intercept and slope, demand for mechanized services, 1978/79-1981/82

		Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-3.43449**[b] (0.167508)	-3.079249** (0.253220)
	$\ell n\ K'$	---	-3.711067** (0.223376)
Fertilizer	α_F	0.113421* (0.057878)	0.213212* (0.078694)
	$\alpha_{F'}$	0.324472** (0.068028)	0.232941* (0.083751)
Labor	α_L	0.624037** (0.077008)	0.540989** (0.084681)
	$\alpha_{L'}$	0.593333** (0.077008)	0.660736** (0.084938)

Table C-11—Continued

Cost Function[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Mechanized Services	α_M	0.091143* (0.031910)	0.098216* (0.032087)
	$\alpha_{M'}$	---	---
Output	α_Y	0.662004** (0.022117)	0.650976** (0.022860)
	$\alpha_{Y'}$	(0.786247** (0.024165)	0.794504** (0.024531)
R^2	---	74.86	91.25
Sample Size	---	858	858
SSE	---	280.164316	279.017104

[a] The unrestricted estimates are the pooled 1978/79 and 1981/82 estimates presented in Tables C-1 and C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-12. Restricted estimates used for testing the stability of the intercept and slope, demand for labor, 1978/79-1981/82

Cost Functions[a]	Parameters	Pooled Estimates	
		Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-3.422311** (0.169218)[b]	-3.202031** (0.225354)
	$\ell n\ K'$	---	-3.597941** (0.206641)
Fertilizer	α_F	0.115176* (0.057146)	0.168889** (0.067679)
	$\alpha_{F'}$	0.330950** (0.068242)	0.284254** (0.075151)
Labor	α_L	0.607617* (0.061467)	0.600734** (0.061600)
	$\alpha_{L'}$	---	---

Table C-12—Continued

		Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Mechanized Services	α_M	0.106474* (0.040479)	0.094816* (0.041212)
	$\alpha_{M'}$	0.071782 (0.044689)	0.096748* (0.047742)
Output	α_Y	0.661462** (0.021802)	0.651066** (0.022893)
	$\alpha_{Y'}$	0.788697 (0.024554)	0.795899** (0.025015)
R^2	---	74.87	91.24
Sample Size	---	858	858
SSE	---	280.082161	279.362619

[a] The unrestricted estimates are the pooled 1978/79 and 1981/82 estimates presented in Tables C-1 and C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-13. Restricted estimates used for testing the stability of the intercept and slope, demand for fertilizer, 1978/79-1981/82, participants

Cost Function[a]	Parameters	Participant Pooled Estimates	
		Constant Intercept	Constant Slope
Constant term	$\ell n\ K$	-2.932853** (0.228584)[b]	-2.538905** (0.289543)
	$\ell n\ K'$	---	-3.148898** (0.247709)
Fertilizer	α_F	0.191334* (0.072784)	0.229783* (0.074479)
	$\alpha_{F'}$	---	---
Labor	α_L	0.569998* (0.104181)	0.551451** (0.103967)
	$\alpha_{L'}$	0.661454** (0.97705)	0.631387** (0.098141)
Mechanized Services	α_M	0.099639* (0.049676)	0.104359* (0.049457)
	$\alpha_{M'}$	0.127372* (0.055991)	0.112250* (0.056115)

Table C-13—Continued

		Participant Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Output	α_Y	0.620405** (0.028735)	0.566581** (0.037642)
	$\alpha_{Y'}$	0.625192** (0.029580)	0.688406** (0.041149)
R^2	---	74.86	88.67
Sample Size	---	363	363
SSE	---	87.387361	86.211463

Note: Since the only significant statistical difference found between participants and non-participants in the previous tests was on account of the demand for fertilizer separate tests were conducted for participants and non-participants of PRODEMATA.

[a] The unrestricted estimates are the participant estimates presented in Tables C-1 and C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

Table C-14. Restricted estimates used for testing the stability of the intercept and slope, demand for fertilizer, 1978/79-1981/82, non-participants

Cost Function[a]	Parameters	Non-participant Pooled Estimates	
		Constant Intercept	Constant Slope
Constant term	ℓn K	-3.663999** (0.252312)[b]	-3.192937** (0.287678)
	ℓn K'	---	-3.854736** (0.256383)
Fertilizer	α_F	0.147476* (0.086762)	0.202238* (0.087481)
	$\alpha_{F'}$	---	---
Labor	α_L	0.583221** (0.108739)	0.542806** (0.108345)
	$\alpha_{L'}$	0.774220** (0.107107)	0.714130** (0.107587)
Mechanized Services	α_M	0.047277 (0.069924)	0.085184 (0.070171)
	$\alpha_{M'}$	0.111180 (0.075692)	0.086348 (0.070171)

Table C-14—Continued

		Non-participant Pooled Estimates	
Cost Function[a]	Parameters	Constant Intercept	Constant Slope
Output	α_Y	0.719857** (0.027093)	0.654867** (0.033272)
	$\alpha_{Y'}$	0.723619** (0.027535)	0.700077** (0.035576)
R^2	---	69.17	92.34
Sample Size	---	495	495
SSE	---	190.185880	186.015406

Note: Since the only statistical difference found between participants and non-participants in the previous tests was on account of the demand for fertilizer separate tests were conducted for participants and non-participants of PRODEMATA.

[a] The unrestricted estimates are the non-participant estimates presented in Tables C-1 and C-2.

[b] Numbers in parentheses are standard deviations.

*Statistically different from zero at 0.05-0.10 probability level.

**Statistically different from zero at 0.01 probability level.

APPENDIX D
COMPARISON OF THE AVERAGE FARM HOUSEHOLD INCOMES BETWEEN PARTICIPANTS AND NON-PARTICIPANTS AND BETWEEN 1978-79 AND 1981-82

Assume that the participant and non-participant average farm incomes are equal.

$$\text{Ho:} \quad \mu_P = \mu_{NP}$$

$$\text{Ha:} \quad \mu_P \neq \mu_{NP}$$

Under the null hypothesis the appropriate test statistic for comparisons between two independent groups of unequal sample sizes and equal population variances is given by

$$t_{(N-2)} = \frac{\overline{X}_N - \overline{X}_{NP}}{\sqrt{\left[\frac{(N_P - 1)S_P^2 + (N_{NP} - 1)S_{NP}^2}{N_P + N_{NP} - 2}\right]\left[\frac{1}{N_P} + \frac{1}{N_{NP}}\right]}}$$

where $\overline{X}_N$ and $\overline{X}_P$ are the sample average farm incomes for participants and non-participants, S_N^2 and S_{NP}^2 are the sample variances for each group and $N = N_P + N_{NP}$ is the overall number of observations. For the case of unequal variances the ordinary test is replaced by

$$t'_{v'} = \frac{\overline{X}_P \quad \overline{X}_{NP}}{\sqrt{\frac{S_P^2}{N_P} + \frac{S_{NP}^2}{N_{NP}}}}$$

which does not follow student's t distribution under the null hypothesis ($\mu_P = \mu_{NP}$). In this case the approximate number of degrees of freedom (Snedecor and Cochran, 1980) is given by

$$v' = \frac{\left[S_P^2/NP + S_{NP}^2/N_{NP} \right]^2}{\left[\frac{(S_P^2/N_P)^2}{N_{P-1}} + \frac{(S_{NP}^2/N_{NP})^2}{N_{NP-1}} \right]}$$

The results of the tests performed using the farm household incomes are shown in Tables D-1 and D-2.

Table D-1. Values of t for significant differences between participant and non-participant average farm household incomes computed from the sample data, 1978/79 and 1981/82

Tenancy Class	1978/79	1981/82
Sharecroppers	1.26	1.74**
Landowners:		
I. 0-10 Ha	1.68**	1.92*
II. 10-50 Ha	2.18**	3.52**
III. 50-100 Ha	1.14	1.20
IV. >100 Ha	0.03	0.67
Sample Average	3.81**	4.82**

*Differences significant at 0.05 probability level.

**Differences significant at 0.01 probability level.

Table D-2. Values of t for significant differences between 1978/78 and 1981/82 average farm household incomes, for participants and non-participants computed from the sample data, 1978/79 and 1981/82

Tenancy Class	Participants	Non-participants
Sharecroppers	1.46	1.88*
Landowners:		
I. 0-10 Ha	1.03	1.36
II. 10-50 Ha	0.74	0.24
III. 50-100 Ha	0.59	0.11
IV. >100 Ha	0.46	0.32
Sample Average	0.12	0.17

*Differences significant at 0.05 probability level.

APPENDIX E
SAMPLE CHARACTERISTICS OF PRODEMATA PARTICIPANTS AND NON-PARTICIPANTS

The summary statistics in this appendix provide a brief characterization of participants and non-participants of PRODEMATA on the basis of their farm resources. The amount of credit per farm is larger for participants than for non-participants of the program (Tables E-1 and E-2). The average participant of PRODEMATA has a larger land holding and a larger capital stock investment in buildings, machinery and livestock than non-participants (Tables E-3 to E-6). Also, he uses more purchased inputs and labor than non-participants (Tables E-7 and E-9). Finally, factors of production are more equally distributed among participants than among non-participants (Table E-10) and participants allocated larger farm areas to crops than non-participants (Table E-11).

Table E-1. Credit per farm (recipients only) by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - Cruzeiros	- - - - - - - - - - -	- - - - - - - - - - -	- - - - - - - - →
Sharecroppers	16,967 (6,086)[a]	20,300 (14,300)	18,300 (5,677)	7,164 (1,186)	9,658 (4,525)	8,993 (3,301)
Landowners:						
I. 0-10 Ha	17,709 (4,489)	17,617 (6,009)	17,676 (3,483)	10,493 (1,865)	20,499 (3,392)	13,352 (1,832)
II. 10-50 Ha	30,989 (3,872)	33,378 (13,629)	31,341 (3,831)	25,954 (2,728)	18,059 (4,502)	24,245 (2,362)
III. 50-100 Ha	76,068 (19,579)	20,087 (3,119)	63,622 (15,981)	62,356 (14,935)	37,090 (13,357)	54,636 (11,210)
IV. >100 Ha	104,312 (19,538)	91,517 (20,677)	99,171 (13,832)	53,956 (8,040)	50,375 (12,575	52,345 (6,988)
Average	43,702 (5,444)	36,761 (7,548)	42,206 (4,566)	32,034 (3,520)	25,181 (3,890)	29,971 (2,722)

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[a] Numbers in parentheses are standard deviations of the mean.

Table E-2. Credit per farm (recipients and non-recipients) by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participation	All Farmers
	← - - - - - - - - - -	- - - - - - - - - - -	- - - - Cruzeiros	- - - - - - - - - -	- - - - - - - - - -	- - - →
Sharecroppers	8,483 (4,669)[a]	677 (584)	1,386 (715)	7,165 (1,186)	1,864 (982)	2,211 (935)
Landowners:						
I. 0-10 Ha	8,117 (2,271)	1,762 (883)	3,577 (1,040)	8,744 (1,749)	2,827 (1,035)	4,559 (936)
II. 10-50 Ha	23,680 (3,222)	5,371 (2,503)	15,427 (2,194)	19,338 (2,320)	4,167 (1,297)	12,185 (1,472)
III. 50-100 Ha	64,542 (17,579)	5,952 (2,003)	38,177 (10,362)	43,302 (11,392)	14,571 (6,173)	30,732 (7,137)
IV. >100	64,561 (18,818)	34,319 (13,576)	47,876 (11,428)	37,094 (8,447)	28,336 (9,438)	32,715 (6,279)
Average	31,456 (4,177)	5,294 (1,350)	16,316 (2,021)	23,975 (2,825)	6,043 (1,151)	13,598 (1,427)

[a] Numbers in parenthese and standard deviations of the mean.

Table E-3. Farm sizes by class of participation and tenancy class, 1978/79 and 1981/82

Tenancy Class	1978/79 Participants	1978/79 Non-Participants	1978/79 All Farmers	1981/82 Participants	1981/82 Non-Participants	1981/82 All Farmers
	← - - - - - - - - - -	- - - - - - - - - -	- - - - Hectares	- - - - - - - - - -	- - - - - - - - - -	- - - - - - →
Sharecroppers	7.68 (2.56)[a]	4.72 (0.33)	4.98 (0.37)	6.65 (1.13)	4.66 (0.37)	4.78 (0.36)
Landowners:						
I. 0-10 Ha	7.54 (0.40)	5.93 (0.38)	6.39 (0.30)	7.68 (0.40)	5.71 (0.36)	6.28 (0.30)
II. 10-50 Ha	26.08 (1.03)	24.69 (1.27)	25.45 (0.80)	26.32 (1.10)	22.22 (1.10)	24.38 (0.79)
III. 50-100 Ha	73.77 (2.59)	70.48 (2.70)	72.29 (1.87)	72.24 (2.42)	73.68 (2.91)	72.87 (1.85)
IV. >100 Ha	127.50 (6.15)	147.66 (11.93)	138.62 (7.27)	140.28 (6.26)	145.18 (12.50)	142.73 (6.89)
Average	38.92 (2.55)	28.20 (2.51)	32.72 (1.82)	42.53 (2.89)	28.02 (2.52)	34.13 (1.93)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-4. Fixed capital stock in buildings by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - - - -	Thousands of Cruzeiros - - - - - - - - - - - - - - - - →				
Sharecroppers	1.116 (0.93)	5.138 (2.81)	4.773 (2.56)	1.015 (0.50)	0.030 (0.01)	0.028 (0.01)
Landowners:						
I. 0-10 Ha	78.079 (25.28)	46.523 (9.44)	55.539 (9.92)	83.235 (14.56)	60.066 (13.02)	66.847 (10.16)
II. 10-50 Ha	142.550 (14.08)	90.885 (11.86)	119.261 (9.56)	151.393 (13.62)	103.019 (14.64)	129.585 (10.09)
III. 50-100 Ha	365.924 (53.08)	155.315 (22.40)	271.150 (33.55)	268.951 (34.75)	206.311 (37.32)	231.546 (25.57)
IV. >100 Ha	290.308 (56.00)	423.987 (98.79)	364.062 (60.37)	315.754 (46.07)	320.413 (15.20)	318.083 (47.65)
Average	180.442 (15.49)	87.936 (10.25)	126.908 (9.08)	176.780 (12.41)	95.054 (10.50)	129.485 (8.24)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-5. Fixed capital stock in machinery and equipment by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - -	- - - - - - - - -	- - - Thousands	of Cruzeiros - - -	- - - - - - - - -	- - - - - - - - →
Sharecroppers	11.450 (10.19)[a]	1.461 (0.34)	2.369 (0.97)	1.015 (0.50)	2.728 (0.52)	2.616 (0.49)
Landowners:						
I. 0-10 Ha	13.058 (3.77)	8.942 (4.97)	10.117 (3.71)	17.820 (5.29)	14.632 (9.38)	15.565 (6.79)
II. 10-50 Ha	45.690 (8.39)	18.501 (3.24)	33.434 (4.92)	42.948 (6.28)	16.962 (2.75)	30.697 (3.68)
III. 50-100 Ha	94.815 (15.68)	37.089 (6.16)	68.838 (9.74)	96.453 (21.59)	78.316 (24.67)	88.517 (16.16)
IV. >100 Ha	79.077 (12.38)	112.775 (29.52)	97.669 (17.23)	91.805 (19.67)	88.739 (28.42)	90.272 (17.0)
Average	51.550 (6.03)	20.158 (3.04)	33.384 (3.18)	53.592 (6.14)	24.642 (4.37)	36.838 (3.68)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-6. Fixed capital stock in livestock by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - - - -	Thousands of Cruzeiros	- - - - - - - - - - - - - - - →			
Sharecroppers	7.800 (3.03)[a]	5.056 (0.69)	5.306 (0.68)	3.281 (1.56)	4.213 (0.62)	4.152 (0.59)
Landowners:						
I. 0-10 Ha	24.112 (7.71)	13.668 (2.69)	16.652 (2.94)	12.475 (2.90)	8.567 (1.84)	9.711 (1.55)
II. 10-50 Ha	107.974 (11.28)	76.984 (7.91)	94.004 (7.22)	56.779 (5.55)	16.962 (2.75)	50.161 (3.68)
III. 50-100 Ha	337.457 (36.08)	188.692 (26.96)	270.513 (25.00)	166.622 (20.605)	131.887 (19.14)	151.425 (14.35)
IV. >100 Ha	453.623 (73.37)	483.012 (104.42)	469.838 (65.30)	256.795 (26.43)	233.747 (44.00)	245.271 (25.33)
Average	159.912 (14.25)	82.576 (10.71)	115.157 (8.81)	89.072 (7.73)	48.237 (5.50)	65.441 (4.65)

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[a] Numbers in parentheses are standard deviations of the mean.

Table E-7. Operating capital expenditures by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - - - - -		Thousands of Cruzeiros	- - - - - - - - - - - - - - - - →		
Sharecroppers	19.533 (12.79)[a]	7.478 (0.95)	8.546 (1.20)	5.957 (2.17)	6.946 (1.06)	6.881 (1.00)
Landowners:						
I. 0-10 Ha	13.525 (2.06)	12.870 (3.96)	13.057 (2.62)	13.150 (2.09)	6.238 (0.90)	8.261 (0.94)
II. 10-50 Ha	39.891 (6.14)	17.674 (1.85)	29.876 (3.56)	35.850 (3.05)	15.003 (2.01)	26.021 (2.01)
III. 50-100 Ha	99.723 (16.57)	34.804 (6.08)	70.509 (10.35)	91.044 (16.03)	33.562 (5.67)	65.896 (9.96)
IV. >100 Ha	70.318 (15.26)	76.867 (19.90)	73.931 (12.74)	110.496 (30.75)	76.320 (32.33)	93.408 (22.16)
Average	48.755 (5.18)	19.712 (2.07)	31.948 (2.58)	49.680 (5.02)	17.135 (2.51)	30.846 (2.67)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-8. Total labor available by class of participation and tenancy class, 1978/79 and 1981/82

	1978/79			1981/82		
Tenancy Class	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - - - - - - - - - Man-day Equivalents - - - - - - - - - - - - - - - - →					
Sharecroppers	1,075.00 (210.05)[a]	731.05 (43.10)	762.32 (44.63)	1,668.75 (352.28)	1,125.45 (68.50)	1,161.08 (69.28)
Landowners:						
I. 0-10 Ha	726.21 (70.67)	647.23 (45.39)	669.79 (38.16)	990.21 (79.03)	887.26 (56.80)	917.39 (46.15)
II. 10-50 Ha	923.11 (44.51)	799.61 (43.90)	867.44 (31.68)	1,138.27 (52.64)	1,076.42 (63.59)	1,109.11 (40.85)
III. 50-100 Ha	1,324.12 (206.19)	1,137.81 (87.68)	1,240.28 (119.80)	1,424.69 (132.28)	1,393.64 (114.99)	1,411.10 (89.17)
IV: >100 Ha	1,196.00 (93.65)	1,238.44 (210.70)	1,219.41 (121.75)	1,910.94 (383.92)	1,639.12 (254.38)	1,775.03 (227.84)
Average	994.36 (48.91)	811.19 (28.94)	888.36 (26.87)	1,254.99 (55.80)	1,115.26 (38.86)	1,174.12 (32.66)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-9. Total labor used by class of participation and tenancy class, 1978/79 and 1981/82

Tenancy Class	1978/79			1981/82		
	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - -	- - - - - - - -	- - Man-day	Equivalents - -	- - - - - - - -	- - - - - - →
Sharecroppers	284.20 (64.99)[a]	192.01 (18.39)	200.39 (17.87)	231.18 (28.41)	205.66 (22.89)	207.34 (21.45)
Landowners:						
I. 0-10 Ha	278.63 (24.68)	203.34 (19.24)	224.85 (15.81)	229.33 (24.86)	148.09 (12.78)	171.87 (12.23)
II. 10-50 Ha	493.23 (24.45)	377.87 (29.30)	441.22 (19.23)	448.76 (23.16)	287.28 (18.22)	372.63 (16.01)
III. 50-100 Ha	975.87 (115.90)	630.20 (62.79)	820.32 (72.36)	897.22 (115.37)	607.08 (81.40)	770.28 (75.70)
IV. >100 Ha	938.98 (108.75)	809.76 (98.86)	867.68 (72.86)	1,080.97 (166.23)	830.48 (120.94)	955.73 (103.58)
Average	577.39 (31.88)	346.27 (18.97)	443.64 (18.17)	559.32 (35.72)	306.96 (18.99)	413.28 (19.55)

[a] Numbers in parentheses are standard deviations of the mean.

Table E-10. Gini coefficients for the distribution of inputs among PRODEMATA farmers by class of participation, 1978/79 and 1981/82

	1978/79		1981/82	
Class	Participants	Non-Participants	Participants	Non-Participants
Land	0.450	0.615	0.463	0.617
Fixed Capital	0.530	0.715	0.498	0.687
Operating Capital	0.558	0.609	0.567	0.635

Table E-11. Land use by class of participation, 1978/79 and 1981/82

Class	1978/79			1981/82		
	Participants	Non-Participants	All Farmers	Participants	Non-Participants	All Farmers
	← - - - - - - - - -	- - - - - - - - - -	- - - - Hectares	- - - - - - - - - -	- - - - - - - - - -	- - - - - - - - →
Crops	9.65 (0.54)[a]	5.84 (0.41)	7.44 (0.34)	9.76 (0.67)	5.32 (0.38)	7.19 (0.37)
Pastures	24.30 (2.05)	18.14 (1.96)	20.73 (1.43)	27.23 (2.30)	17.55 (1.96)	21.63 (1.50)
Other uses[b]	4.98	4.23	4.55	5.55	5.15	5.32
Farm size	38.93 (2.54)	28.21 (2.51)	32.72 (1.82)	42.54 (2.89)	28.02 (2.52)	34.14 (1.93)

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[a] Numbers in parentheses are standard deviations of the mean.

[b] Difference between the farm sizes and land with crops and pastures.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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